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Principles and Practice of Osteopathy

—BY—

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INTRODUCTION

J. H. Styles, Jr., D. O.

Osteopathy is an exact science. Its basic, elemental features are as precise and changeless as the laws of the Medes and Persians. It was given tangible form and objective expression by the master genius of the greatest anatomist and physicist who ever lived. Its fundamental principles are reared upon sound physical facts; and the tenets of its splendid philosophy are, without exception, corollaries of demonstrable anatomic propositions.

There was not the shadow of a doubt in the mind of Andrew Taylor Still, nor in the minds of his immediate disciples, concerning the definite and eternally abiding interrelationship between structure and function. Indeed, the initial success of osteopathy as a universal therapeutic agency was based upon a profound and comprehensive appreciation of the specific pathologic significance of all mechanical perversions of the body machine.

Time, however, has introduced many vicious modifications and changes. Heresies of every sort and description have crept into osteopathic thought, distorting or obscuring original findings and paralyzing the once implicit faith of the osteopathic physician in the universal efficacy of his peculiar system of therapeusis.

Nowhere has this utterly demoralizing tendency been more apparent than in the realm of osteopathic diagnosis of bony lesions and the technic of their adjustment. It is not too harsh a judgment to assert that the technical procedures of a majority of modern osteopaths are too often based upon unsound and empiric personal opinions rather than upon scientific facts.

Osteopathy, reduced to its simplest forms, is a matter of living anatomy and physics; and its technical maneuvers are exact geometric propositions. No matter how the practical

application of the latter may be modified to suit the physical limitations of the individual physician and the immediate needs of his patient, their mechanical features must be at all times consistent with the requirements and limitations of the geometry of the osseous framework of the human mechanism.

Countless exploiters of technic have flourished since the Old Doctor's time. All sorts of instructors in osteopathic mechanics, good, bad and indifferent, have held the stage for varying seasons and expounded their conceptions of the practical phases of osteopathic science and art.

Until recently, however, no individual has in any sense dominated this essential field of professional endeavor. Indeed, most so-called technicians have been and are but more or less blundering artisans in osteopathy. They have come and gone, at variance with each other and often with the Founder of their science.

Fortunately for the future of scientific physio-therapy an osteopathic Moses has at last loomed upon the horizon of this heterodox age and, by the sheer compelling power of his anatomic and mechanical genius and practical demonstrations initiated a wide-spread and saving revival of faith in basic first principles.

Dr. C. H. Downing is indubitably the greatest osteopath since Andrew Taylor Still. He is a thorough-going scientist, a natural-born bone-adjuster and an outstanding teacher of his art.

This present volume represents the most complete and scientific text on osteopathy extant. It is practical, entirely readable and extremely easy to follow. Diagnostic and technical procedures are presented in such a manner as to make their visualization and subsequent execution notably simple.

Each chapter is complete in itself and comprehends all that is scientifically proven with regard to the diagnosis and

physical adjustments of lesions occurring in the anatomic locale of which it treats.

Dr. Downing's work in technic is easily the outstanding feature of this osteopathic generation. This record of his modus operandi faithfully and literally outlines that technic so that any physician of ordinary intelligence and average attainments may readily grasp and apply its principles.

If the writer of this introduction had to dispense with all of his osteopathic books save one, he would choose to retain his Downing. The spirit of osteopathy permeates it; the greatness of osteopathy shines through it; and the therapeutic universality of osteopathy is its lodestar.

Osteopathy is either supreme in therapeusis or it is nothing. If, therefore, the principles upon which Andrew Taylor Still founded his system are fundamental expressions of natural law, nothing else can take their place nor constitute a satisfactory substitute for them. For there can be no playing fast and loose in science.

Dr. Downing believes, as the Old Doctor believed, that osteopathy is all in all. His science and art have no limitations. Indeed, they are as untrammelled as infinity, for they are but the conscious appropriation and intelligent direction of infinite forces.

FOREWORD

By F. P. Millard, D. O.

Few men should write a book. Few men have that to impart which justifies it. C. Harrison Downing, D. O., is one who has.

Some one said the other day, "I don't see how a young man can teach me anything." I looked at him and said nothing ---but thought much.

Unto a few is given insight---a reflection of genius. A small book could contain the names of all the real geniuses in the world. Dr. Downing is a genius.

I have yet to see a man who could produce a splendid article along any line, without having trained himself thoroughly for that work. Dr. Downing is highly trained.

The best violin the world ever produced was made a few weeks ago. There are those who may imagine it was made over night. Critics listened to the maker play his violin behind screens, and then heard him play on a Stradivarius, supposedly the best violin in the world. Possibly it was, until this new genius produced his masterpiece. Investigation revealed that this man had been making violins for about forty years; had lived and loved his work, and devoted his entire time and attention to the one idea—that of producing something better. His dreams were along the line of fairies playing on strings. His visions were those of a symphony that would almost parallel that of the angels.

Dr. Downing had a vision, too. No man can make me believe otherwise. He likewise, must have burned the midnight oil, perused many a musty tome; made many an intricate adjustment. No man can understand the mechanism of the human anatomy without tremendous concentration. By nature, Dr. Downing was given body-mechanical talent. Were it possible to visualize his cerebral cortex, I imagine it

would be full of joints. He can joint a joint quicker than any man I have ever seen. He is adapted to that work.

It is possible for some men to understand the mechanics of the human body; likewise, it is impossible for other men, if they lived three lifetimes. An individual gifted by nature along a certain line, can, by concentration, comprehend a subject in one year; while another, digging away and practicing for twenty years, has to be painstakingly taught principles that he had not discovered during these twenty years of practice.

Some of the greatest inventions in the world were by young men. Some of the greatest poets, the greatest playwrights, the greatest orators, were men in their early years. Age has nothing to do with it. It is a matter of intellect, talent and comprehension.

Give credit wherever it is due. Praise the genius; encourage him. He is responsible for all progress and evolution. He is usually a sensitive soul. As a rule he does not live long. He burns out his energy. Get the best out of him while he is running full speed.

There is such a thing as a man having quality along with quantity. A writer, for instance, may produce a novel a year for several years, like that great man from Indiana. A "Mark Twain" could write twenty-five volumes in comparatively short time, and yet make every word valuable. Schubert produced several hundred great compositions, yet he died at the age of thirty-two.

If an osteopath can produce a better book on the mechanics of the human body and explain the various joints and their articulations more thoroughly than anyone else, give him the credit that is due him.

There may be members of the fraternity who think that ten or fifteen dollars paid for a book is ridiculous. If so,

they do not stop to realize that the author has spent hundreds of hours, possibly thousands; gone without sleep; forgotten his food, turned away his practice, neglected his other affairs and become almost exhausted at times, in trying to complete the work that he has visualized. On and on he goes, building the structure that to him once was only a dream. The practical vision becomes a reality. His product is placed upon the market. His fellow men have access to all of his findings and research work for a pittance. There should be no complaint. It is impossible to pay the author of such a book a price commensurate with what the reader gains by perusal and obtaining the viewpoint of the one who has done the research, concentrating and heavy work of compilation; gone through the throes of publication, and last, but not least, paid the printer's bill.

When a man with a great message leaves his practice, forgets self, devotes his time to instructing his fellow men, and absents himself from his own fireside to travel to distant cities, states, and possibly across the continent, he should be appreciated, encouraged, welcomed and listened to with respect.

If every osteopath could appreciate the wonderful work that Dr. Downing is doing, and attain his viewpoint by a few lessons of instruction, he would advance years in his profession, save time and effort and increase his renown through the more successful handling of a larger list of gratified patients.

We are justly proud of Dr. Downing and his accomplishments. There may be others who have as good technic, but we know that there is no one in our profession who can make adjustments in all parts of the body more cleverly and with better results than Dr. Downing.

PREFACE

In preparing this treatise, the author has not attempted to cover osteopathic therapy in all of its phases. Indeed, the subject is so exhaustive that this could not be accomplished in a single volume. It would require a series of books and even then the whole might not be told, as the topic is so comprehensive and its possibilities so great that new developments are being made daily and will continue to be as time goes on and as the practical aspects of this great branch of science unfold.

There are a great variety of themes upon which the author has not touched but with which the student and practitioner have become familiar in the class room and in general practice. He has sought to confine himself rather to the most important of newer developments in osteopathy: more particularly to those which his own experience, observation and research have brought to light and which have been demonstrated to be of value in reducing the discomfort of the patient, lessening the effort of the operator and increasing the effectiveness of his labors, and all with a vast economy of time.

His activities have uncovered other topics of far reaching significance to practitioners and students which, up to this time, have not been presented in a lucid manner. It is his intention to treat of these matters at some future time when other duties will permit.

This present work is published in the belief that it will increase the technician's efficiency and simplify the labors of any physician or student who will study it conscientiously and demonstrate in his daily practice the principles outlined.

CARTER HARRISON DOWNING.

THIS BOOK IS DEDICATED
To My Wife
FLORENCE RUSSELL DOWNING,
who has splendidly served as a sympathetic and an untiring amanuensis; to
J. H. STYLES, JR., D. O.
whose literary advice has been invaluable; to
H. C. DAVISON,
who has rendered a fine technical assistance; and to
R. H. WILLIAMS, D. O.,
whose faith has made the volume possible.

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Chapter I.

Osteopathy, the Science

Osteopathy is a philosophy of medicine (healing) having a complete system of therapeutics, basing its treatment of all abnormal conditions of the body on the natural laws and vital principles governing life: namely, the adjustment of all these vital forces of the body, whether physical, chemical or mental, in so far as we have knowledge thereof.

---C. H. Downing.

"Osteopathy is the name of that system of the healing art which places chief emphasis on the structural integrity of the body mechanism as being the most important single factor in the maintenance of the well being of the organism in health or disease."---(Dr. C. B. Atzen.)

Mason W. Pressley, A. B., Ph. D., D. O., defines osteopathy as: "that science which consists of such exact, exhaustive and verifiable knowledge of the structure and function of the human mechanism, anatomically, physiologically and psychologically, including the chemistry and physics of its known elements, as has made discoverable certain organic laws and remedial resources within the body itself, by which nature, under the scientific treatment peculiar to osteopathic practice apart from all ordinary methods of extraneous, artificial or medicinal stimulation and in harmonious accord with its own mechanical principles, molecular activities, and metabolic processes, may recover from displacements, disorganizations, derangements, and consequent disease and regain its normal equilibrium of form and function in health and strength."

A science and philosophy so all-embracing as osteopathy is difficult to define. Its program is too vast for ordinary comprehension. It defies strict analysis.

Structure and Function: All living matter is subject to the "LAW OF CHANGE." As represented in man, evolution should be taken as adaptational or environmental, the effort of the body to maintain its highest efficiency. Consequently the normal for an individual is variable and subject to change. Normality is never twice alike. The relationship between structure and function is never constant. Both develop co-ordinately, one dependent upon the other, and this same interdependence holds true throughout every manifestation of life, throughout all its changes, whether in health or disease, and regardless of the plane affected, whether physical, mental, or chemical.

Thus, the integrity of one is always predicated upon the integrity of the other. There cannot be a change or perversion of function without a corresponding change in structure, whether it be within or beyond the limits of what is broadly considered normality: and vice versa, we cannot have disturbed or perverted structure without a corresponding effect upon function.

There is no lost or vacant space in the normal body economy, for genetic changes and growth of external structure proportionately develop hand in hand with, and are dependent upon the development of the contained viscera until full completion and maturity is reached. Therefore, it is obvious that the shape, size, and contour of those organs will predestine and determine to a marked degree the appearance and proportion of the external architecture.

After the completion of ossification, however, splanchnic changes no longer greatly affect skeletal morphology; and it may well be stated that from that time on the container largely determines the size and shape of its contents. External measurements of the physical being will thereafter give an approximate estimate of the proportions of internal organs. Thus, by inspection and other diagnostic and physical methods, we can forecast with a fair degree of certainty

physical predispositions and latent potentialities which may later become of sufficient import to occasion disease.

The function of an organ depends upon and is proportionate to its development, although physiological demand is, in the last analysis, the primary incentive and trophic stimulus to complete somatic evolution. Generally speaking, then, function depends upon structure after maturity. This, however, is not a fixed postulate inasmuch as the evolutionary processes of life must still continue and the physiological demands be answered, although less readily than before. The higher the organism ascends in the mammalian sphere, the more complex its nervous system becomes and, therefore the more easily it is thrown out of functional balance.

The human body is an aggregate of cells and tissues, a sum total of parts mutually banded together, dependent one upon another and in a delicate state of morphological and physiological balance. Moreover, none of the component parts of such an organized being can be modified without other parts being affected by reason of the close functional relationship between its constitutents. Therefore, if normal functioning is not maintained, or coordinate balance re-established by proper adjustment, death of the whole organism ensues: for, because of this very specialization, the parts of all higher forms of life are not endowed with the power of independent and indefinitely continued living. As Pearl states: "this is the price paid for differentiation of special function."

"In every epoch of life, special morbidity resides in the special morphology of the organism."---De Giovanni.

"There is a margin of safety or zone of physiologic variation within which both structure and function may fluctuate but remain within the boundaries necessary to maintain life." ---Deason.

Significance of Structure in Regard to Disease: Hulett says: "Function is infinitely self-regulative"---that structure is less immediately and less completely subject to vital control---especially the more inert tissues such as bones, ligaments, cartilage and other connectives. Hence, where disorder is maintained, we assert from reason and observation that structural perversion is the factor that prevents a return to normal functioning.

The unhampered tendencies of the body are always toward the normal in both health and disease. All reactions of the body, whether constructive or destructive, have that ultimate end in view. The logical conclusion, therefore, must be that perverted structure is the greatest preventative to a return to normal in disease, provided all external causes leading to perversion of function are eliminated.

The Cell in Disease: The human cell is a nucleated, circumscribed mass of protoplasm capable of assimilation, growth and reproduction. It is the albuminous material basis of life. Cells collectively form tissues; tissues, organs; and organs, systems. Each cell has its particular function. "The cell cannot of itself cause disease either in itself or in its neighbor. It is inherently healthy and a disturbance in its metabolism is due to impairment of its blood, lymph, nerve or protoplasmic continuity." (Hulett.) This is fundamentally true.

A disordered cell shows four primary disturbances. They are:

1. Cellular irritability.
2. Metabolic.
3. Structural.
4. Special functional.

Irritability may be increased or decreased by thermal, mechanical, chemical, electrical, or nervous variations. Primarily, irritability is increased; secondarily, it is decreased,

due to the fact that potential energy is ultimately diminished within the cell beyond a point of response.

Metabolism is influenced in that catabolism is greatly increased and is concomitant with heightened irritability. It is likewise decreased only when potential energy is lost or depleted beyond a point of response.

The special function of a cell is the expenditure of kinetic energy and is dependent upon potential energy---therefore the same rule obtains in this connection. The cell as a defensive organism is of the very greatest importance. For example: in the presence of bacterial infection we have a poisonous toxin produced which acts as a chemical irritant or stimulus to the cell. Irritability is increased and catabolism immediately follows in the form of anti-bodies or anti-toxins. The cell, in order to maintain its own individual life, must fight for it and to carry this out with the highest degree of efficiency there must be a like efficiency on the part of the circulation and nerve supply, unless the cell has been the recipient of direct injury and then it cannot perform its function. For only through these channels can the material necessary to cellular anabolism be obtained, or substances manufactured to maintain the increase of function which is demanded by way of defense; namely, the formation of anti-bodies and anti-toxins. We can therefore logically state:

> First—Faulty metabolism on the part of the cell begins when that cell does not functionate in the manner or extent intended by nature.
>
> Second—This physiological deficiency is due to a lack of potential energy caused by a perverted circulation or nerve supply, thereby lessening the cell's resources; or else it is due to direct injury to the cell.

The Osteopathic Lesion: The osteopathic lesion is any structural disturbance with consequent functional deflection. The effects produced by lesions are by direct or secondary pressure. The structures involved by this pressure are arteries, veins, lymph

channels, nerves and adjacent tissues. The more adynamic or static the structure affected, the lower its power of self-adjustment. Vessels and nerves are highly self-adjustive. The severity of the symptoms occasioned by a lesion thus depends more upon the length of time it persists, the rapidity of occurrence and the nature of tissues involved than upon the extent of structural defect. Moreover, the nature, rather than the amount of structural perversion will determine the prognosis. This is due to the greater vital capacity of certain tissues and the extent of nature's adaptational efforts.

A lesion may be **primary** or **secondary.** A **primary lesion** is one directly related to the cause; i. e., trauma. A **secondary lesion** is one dependent upon a previously existing lesion. It may also be adaptational; as, for instance, the hypertrophied heart in valvular diseases. The **spinal lesion,** when secondary, is produced by the great medium of nerve reflex and may persist to a variable extent after the causative factor, or primary lesion, has disappeared. Likewise, **secondary lesions** may be counterbalancing.

Major lesion is the term applied to the lesion causing the greatest functional disturbance. A **minor** lesion is one which causes a lesser disturbance. The latter is usually reflexive from a major lesion.

The **latent** or **potential spine lesion** is a palpable ligamentous and osseous anomaly which is evidenced by no immediate or active symptomatology which can be traced obviously, although it seems to be a predisposing factor and lowers the margin of safety of that particular organ or tissue with which it is related. If not beyond the power of compensation by collateral blood and lymph supply, its irritative stimuli are held in partial abeyance thereby, and the functions of structures within the sphere of its influence will be conducted on a lower margin but within the limits of a somewhat variable and elastic state of so-called normality. Indeed, the removal of functional etiological factors may precipitate spontaneous

adjustment providing the adynamic or static structural factor be insecure and dependent upon such a vegetative background. Thus, chronicity will more or less determine the relative fixation or stability of the structural factor inasmuch as it encourages greater structural stabilization. Recuperative and adjustive possibilities vary under many conditions and in various individuals, so that this allows of no fixed postulate.

Osteopathic lesions (spinal) are usually bony subluxations with ligamentous tension or shortening and muscular tension or contracture. By impingement lesions affect the circulation, particularly at certain points of entrance and exit from the spinal cord. The result is either passive hyperemia (drainage affected); rarely anemia (arterial impingement) with ultimate nutritional disturbances and impoverishment of nerve supply. These perversions are accomplished by way of the lymphatic channels, inasmuch as all terminal circulation is conducted through these avenues. Due to pressure, edema first appears in the meningeal cul-de-sac between the posterior root and the superior pole of the posterior root ganglion, and immediately begins to markedly interfere with the proper circulation of cerebro-spinal fluid at this point. Hence, sensory impulses are disturbed as they pass from the cells in the posterior root ganglion to the spinal cord; consequently, this pressure edema constitutes a prolific first cause of peripheral and visceral pathological physiology.

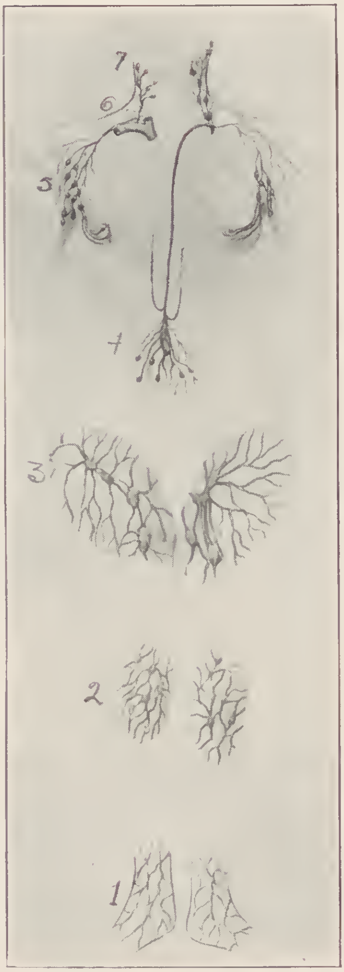
Important in this group of cells is the **Cell of Dogiel,** a connector which serves to conduct impulses from the posterior root to the neurone of Golgi, type II; and also, together with sensory neurones from the posterior root ganglion, serves to link up, by synapsis with conduction paths, both higher and lower reflex arcs as well as that of the same segment. Thereby impulses are carried from the sympathetic to the cerebro-spinal system, to be interpreted and acted upon.

Lesions may be classified as follows:

1. **Positional**—In the form of subluxations, dislocations and displacements.
2. **Gross Anatomical**—In the form of contractures, atonicities, hypertrophies, hyperplasms, atrophies, fatty infiltrations, tumors, etc.
3. **Microscopic Pathological**—In the form of parenchymatous, fatty, colloid, albuminous, mucoid, hyaline and other cellular degenerations.

The Circulation: Dr. Still stated in 1874: "A disturbed artery marks the time to an hour and minute when disease begins to sow its seeds of destruction in the human body." At that time he further asserted that in no case could this be accomplished without a broken or suspended current of arterial blood which by nature is intended to nourish and supply all nerves, ligaments, muscles, skin, bones and the artery itself; and, that the rule of the artery must be absolute, universal and unobstructed or disease will be the inevitable result. All nerves depend wholly upon the arterial system for their nutrition and such qualities as sensation and motion, even though, by the law of reciprocity, they furnish vital force and sensation to the artery itself and regulate its nutrition.

The artery carries nutritional substances and oxygen to the tissues. Its functional impairment results in deficient oxidation. Contrariwise, any circulatory perversion affects the respiratory function. Upon the lymphatic circulation falls the duty of direct cell-feeding and drainage. Veins are charged with general drainage. They are more easily compressible than arteries on account of their thinner and more flaccid walls. Interference with their physiological activities results in passive hyperemia and a storing up in the tissues of catabolic products.



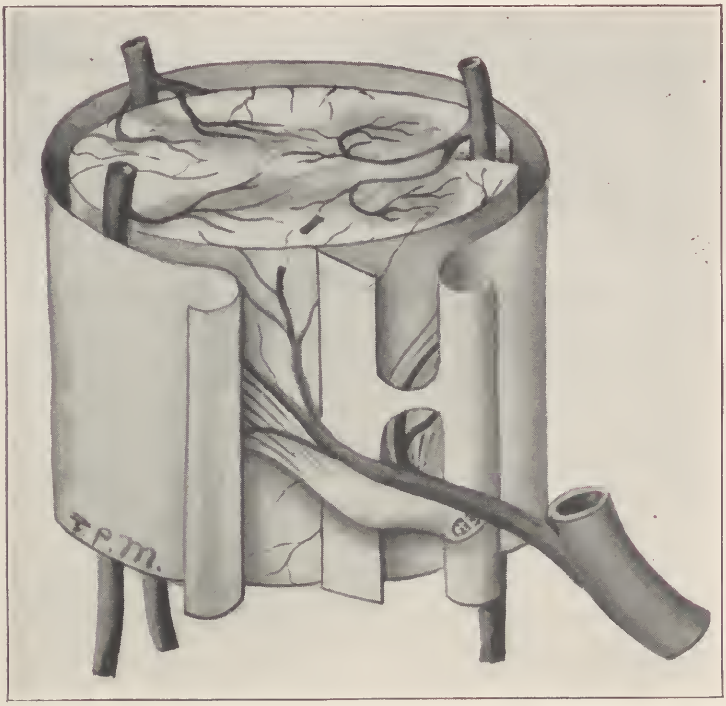
Seven points of palpation in making a lymphatic examination.
—Courtesy of F. P. Millard, D.O.

Any decrease in normal blood or lymph supply to the cord or drainage from the cord diminishes the efficiency of the cells in that structure. The presence of oxygen is necessary for normal nerve conductivity, which is decreased in the presence of carbon dioxide (Bulletin 1---A. T. Still Research Inst.) Increased arterial supply and venous drainage in-

creases the activity of the segment affected (Series 16 & 17, Bulletin 1, A. T. Still Research Inst.)

Using the Marchi, Weigart, Pal, Williamson and Nissl methods, Deason has shown that the coats of the arterioles, capillaries, veins and in some instances arteries, are deranged from the endothelial cells through to the muscle fibers and from the outer layer into the surrounding tissues; and that from the escape of blood plasma to leukocytal invasion, diapedesis and hemorrhagic foci, the pathological picture is complete. Small arteries may even show signs of endarteritis.

Burns (A. O. A., July, 1921) states that the lesion affects the circulation through the sensory ganglion of the same and immediately neighboring segments, usually causing at first a slight and temporary constriction, then an inconsiderable but more lasting dilation of the arterioles. Such a ganglion presents a slightly redder appearance than normal. The liminal or threshold value of neurons of the first class is lowered, so that stimulation which is usually subliminal is now able to initiate sensory impulses. Thus, by reason of the slight ganglionic congestion, many normally imperceptible sensations are appreciated. Edema is coincident with congestion, and occasions an increase in the carbon dioxide content of intercellular fluids. This, together with the pressure effects of the edema, partially blocks the passage of impulses over conduction paths. A decrease in total sensation results and impulses fail to affect the spinal centers, the cerebellar or basal ganglia, the centers for control of complicated motions and higher cortical centers. This results in an admixture of increased, decreased and modified sense-perceptions, which operate to the perversion of the sentient faculties of the conscious, and the vegetative functions of the subconscious, mind.



Above illustration shows circulation in a section of the spinal cord and spinal arteries, together with correlating spinal branches from the intercostal.

—Courtesy of F. P. Millard, D.O.

The spinal branches of the sacral, lumbar, intercostal and vertebral arteries accompany the spinal nerves through the intervertebral foramina, traverse dura mater and arachnoid and divide into a dorsal and ventral radicular artery. These accompany nerve roots to the surface of the cord and then break up into an anastomosing plexus in the pia mater. From this plexus are derived three tortuously coursing longitudinal arteries and numerous central branches which penetrate the cord direct. The anterior spinal artery zigzags along the anterior median fissure. The two posterior spinal arteries course longitudinally near the lines of entrance of the dorsal root fibers, one on each side.

The venous system is quite similar to the arterial. The blood of the central arteries collects into corresponding central venous branches which converge into a superficial venous plexus in which are six main longitudinal channels, one along the posterior median sulcus, one along anterior median fissure, and one along each of the four lines of the nerve roots. These comprise the posterior and anterior external spinal veins.

The **vasomotor system** deserves special mention in this connection, for treatment of it by osteopathic measures does much to regulate and to coordinate the distribution of the blood. Physiologists have demonstrated the fact that there are both constrictor and dilator fibers. The secretory augmentors and inhibitors depend partially for efficient functioning upon co-operative efforts in the vasomotors.

The caliber of capillaries and venules may, under a diversity of conditions, dilate or contract individually and inde-

pendently. The maintenance of this tonus is dependent upon the supply of blood received. When the vessel gets little blood, its tonus diminishes and dilatation follows. Thus it will readily be seen that it must, perforce, become relaxed and admit more blood in order that it may regain its normal tone.

It is logical to assume that every capillary alternately opens and closes and that this shunting of blood from one place to another allows all areas to be uniformly supplied and irrigated sufficiently. This is a specially protective mechanism for those parts which may be poorly supplied as well as a physiologic one for those demanding an extra supply during functional activity.

Superimposed upon and controlled by vasomotor influence, this inherent capacity of terminal vessels acts as an automatic stimulus to vasomotor activity and in case of vasomotor paralysis it will, to some degree, control the situation irrespective of its loss of higher control. Some authorities claim that there is an additional chemical factor which has some control over the action of the capillary and venule. This is indicated by the action of certain drugs. The hormonic action of the internal secretions of certain glands may also have some effect on their behavior. In this connection it is interesting to note the experiments of Sajous which go far to prove that internal respiration is not due to partial pressure of gases but rather to the specialized and selective action of the endocritic product of the adrenal gland, which gives to hemoglobin a peculiar affinity toward oxygen.

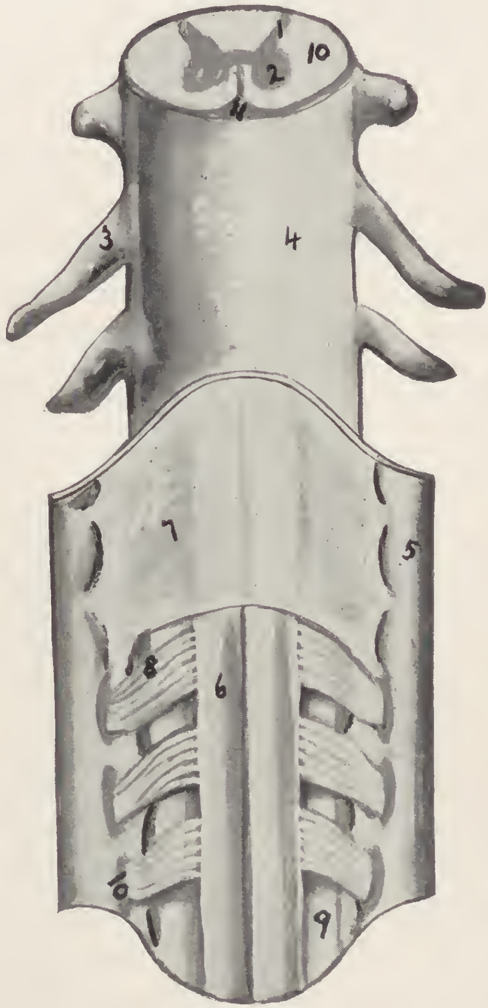
Disturbances of sympathetic vasomotor innervation are common. Generally speaking, these conditions are due to hypotonia of the sympathetic, with resultant derangement of the normal, circulation of the blood; especially in the hands

and the feet. They signify vasomotor instability. This sympathetic inefficiency may be an hereditary weakness of the sympathetics, or part of a generalized acquired atonia, or vagotonia. Trophic disturbances may also be be noted. Indeed, such perversions of the autonomic system will often show a change in the blood picture so that occasionally a high leukocyte count and slight eosinophilia is noted. Confirmed vasomotor instability at the menopause is responsible for hot flashes and pathologic changes in the distribution of the blood. The irritative state of the vasomotor centers allows splanchnic vasoconstriction, primarily forcing blood into the superficial peripheral vessels; then the stimuli are suddenly directed elsewhere and active vasodilation within the viscera follows, aspirating blood into these vessels.

In acidosis the capillaries take up the products of incomplete combustion in the body, which are non-volatile acids. These toxins find their way into the general circulation, displace carbonic acids by combining with the alkalis present and thus the alkaline reserve is diminished.

An osteopathic lesion, inasmuch as it produces a definite, localized disturbance of vasomotor control, eminating from the involved spinal segment, results in specific vasomotor imbalance in the organ or tissues supplied from that segment.

The following illustration shows an anterior view of the cord and membranes. The lymph bathes all these cells and tissues. (1) Posterior horn. (2) Anterior horn. (3) Spinal nerve with covering. (4) Dura mater. (5) Turned back. (6) Spinal cord bared. (7) Arachnoid. (8) Anterior nerve roots. (9, 10) (top number) Lateral surface of cord. (10) Anterior nerve passing through dura mater.



From within outward the spinal cord is supported and protected by three membranes, the pia mater, arcahnoid, and the dura mater, the spaces between which are supplied with the encephalo-spinal or cerebro-spinal fluid which gains access to the brain and ventricles through the foramen of Magendie. The cerebro-spinal fluid is a lymph formation. The continuation of the same three coverings of the spinal cord envelopes the encephalon also.

Arterial Tension is defined as normal, continuously stable vasotonus, at a radial maximum tension of between one

hundred and forty to one hundred and fifty mm. hg. In other words, a state of arterial tension is that condition in which the automatic, spontaneous and reflex excitability of the cardio-vascular and neuro-muscular mechanisms possess a high grade of coordination and adaptability to varying demands.

1. Signficance of Low Blood Pressure (Hypotension)
    - (a) Congenital conditions
    - (b) Endocrine exhaustion
    - (c) Certain constitutional diseases and infections
        1. Tuberculosis
        2. Pneumonia
        3. Typhoid, etc.

2. Significance of High Blood Pressure (Hypertension)
    - (a) Factors which decrease the peripheral circulation or diminish the caliber of its vessels.
    - (b) Increased volume of blood, other factors being equal.
    - (c) Increased rate of flow, other factors being equal.
    - (d) Abnormal viscosity.

Sympathetic System: It is not the author's object to treat exhaustively upon this extremely important subject, other than as it may clarify and correlate certain viewpoints of value to osteopaths as a profession. It must not be forgotten that reflexes are of tremendous importance to the osteopath. The reflex arc is probably the main channel of reciprocal innervation in the presence of the osteopathic spinal lesion; moreover, its field is unlimited and little understood. The time may come when the osteopathic fraternity will understand its intricate workings to the extent that it shall better know how to direct its therapeutic energies more specifically.

The Autonomic Nervous System is divided into two parts:
1. Sympathetic (Thoracico-Lumbar outflow).
2. Parasympathetic (Cranial, midbrain, medullar and sacral outflow).

When the sympathetics and parasympathetics are distributed to the same structure, their effects are antagonistic.

The sympathetic nerves and the sympathetico-trophic glands of internal secretion; namely, the thyroid, adrenals, parathyroids, etc., aid in the defense of the organism against such conditions as enemies from without, such as infections, pain, anger, injury, heat, cold, asphyxia and shock. From the viewpoint of metabolism, the sympathetics are naturally destructive in their activities (catabolic) together with the glands with which they are intimately associated. It is interesting to note that the chromophyl element of the suprarenal is an embryological outgrowth of the sympathetic nervous system.

Parasympathetic nerves and parasympathetic glands, such as the pineal and pituitary bodies, and intestinal glands, provide the body with an appetite and its secretions, such as saliva, gastric juice, bile, pancreatic fluid and intestinal reagents, for the digestion of food and motive power to the gastro-intestinal tract for the combining of the food materials with juices, propelling it onward, and for expelling refuse from the body. From a metabolic viewpoint, their actions are anabolic.

The antagonistic actions of both parts may be tabulated as follows:

Sympathetic	Parasympathetic
1. Pupillary dilatation	1. Pupillary contraction.
2. Cardiac acceleration	2. Cardiac retardation.
3. Peristaltic inhibition	3. Peristaltic stimulation.
4. Retardation of digestive processes.	4. Stimulation of digestive processes.
5. Contraction of vesical and rectal sphincters.	5. Relaxation of vesical and rectal sphincters.

The Nervous Mechanism: The generic nervous system is divisible into two parts:

1. The central nervous system, composed of:
   (a) The brain or encephalon
   (b) The spinal cord or medulla spinalis.
2. The peripheral nervous system, composed of
   (a) The cranio-spinal nerves.
   (b) The sympathetic.

Their association is so intimate that subdivision is only arbitrary.

Physiologically, and to some extent structurally, the nervous system is also divisible into:

1. The cerebro-spinal or somatic system, consisting of
   (a) The central system.
   (b) The cranio-spinal or cerebro-spinal nerves.
2. The sympathetic or autonomic system, which is that portion of the peripheral nervous system, especially concerned with the re-arrangement and distribution of impulses to and from the brain and cord, and
   (a) The secreting glandular epithelium.
   (b) The cardiac muscle.
   (c) Non-striated visceral muscles (intestinal)
   (d) Certain striated visceral muscles (rectal).
   (e) The arrectores pilorum.
   (f) The non-striated vascular muscles.

Although the activities of the sympathetic system are usually under the control of the central nervous system, it may mediate impulses without involving the latter at all. Biologically considered, the sympathetic system is an outgrowth of the brain and spinal cord and remains anatomically and physiologically connected with them throughout life.

It consists of a complex of spinal and cranial nerve-fibers and sympathetic fibers intermingled with groups of ganglionic cells and is made up principally of:

1. A pair of gangliated cords or trunks.
2. Four great prevertebral plexuses.
3. Terminal ganglia and plexuses.
4. Nerve fibers (communicating and distributive).

The cerebro-spinal nerves are forty-three in number on either side; twelve cerebral, attached to the brain, and thirty one spinal, connected with the medulla spinalis. They serve as means of communication between and control of

1. Special and general senses.
2. Voluntary muscles.

The nerve fibers encountered within the sympathetic system include two sets:

1. Those derived from the cerebro-spinal system, which are usually medullated;
2. The sympathetic fibers proper, which are usually non-medullated.

The distinction between medullated and non-medullated fibers is, however, somewhat indefinite, since the medullated spinal or cranial fibers often become non-medullated before terminating; while the sympathetic fibers are occasionally medullated throughout their course.

Physiological and anatomic investigations have shown that autonomic nerve-fibers arise primarily, though indirectly, through the intervention of ganglia from four chief regions in the central nervous system:

1. From the midbrain emerging in the third cranial nerve and passing via the ciliary ganglion;
2. From the bulbar region, emerging in the seventh, ninth, tenth and eleventh cranials;
3. From the thoracic spinal nerves (first thoracic to second lumbar).
4. From the sacral region by way of the so-called nervi erigentes, supplying the lower colon and genital organs without passing through the gangliated cord.

The nerve impulses discharged by these cells are transmitted indirectly, not through one, but through two successively arranged neurons. The **first,** a fine white, medullated fiber, emerges from the medulla or spinal cord in association with the large motor-root fibers, passing to the skeletal muscles (anterior primary division), and after a variable distance leaves these fibers to arborize around and become physiologically related to nerve cells in a sympathetic ganglion. The **second,** a fine, dark, medullated fiber, emerges from one of the cells of this ganglion, and after pursuing a much shorter or longer course, branches and becomes histologically

and physiologically related to cardiac, non-striated visceral or vascular muscle tissue and glandular epithelium.

The **first neuron,** originating in the cranio-spinal area, is termed pre-ganglionic and is usually medullated.

The **second neuron,** originating in the sympathetic ganglion, is termed post-ganglionic and usually unmedullated.

The cerebro-spinal and sympathetic nerves convey various impressions. The sensory fibers, called also centripetal or afferent fibers, transmit to the nervous centers impressions made upon their peripheral extremities and thus:

(a) the mind, through the medium of the somatic afferent nerves becomes aware of external impressions;

(b) certain automatic centers in the central nervous system are called upon through the medium of the splanchnic afferents, but without evoking consciousness.

The centrifugal or efferent fibers transmit impressions from the nervous centers to the parts to which the nerves are distributed. These impressions either excite muscular contraction or influence the processes of growth, nutrition and secretion.

For convenience of study it is well to consider such nerves as having their cell of origin, the spinal root ganglion (afferent somatic), in the central nervoussystem, and cerebro-spinal nerves and all nerves having their cells of origin extrinsic to this as belonging to the sympathetic system. However, it must be borne in mind that actually there are not two nerve systems, but one. This may morphologically be divided into two portions:

1. That which has its peripheral distribution in association with skeletal muscles;
2. That which has its peripheral distribution through the intervention of a series of ganglia, and is associated with cardiac or non-straited muscle and glandular epithelium.

The rami communicantes serve to connect the sympa-

thetic with the central nervous system. They are denominated **white and gray** rami communicantes.

White rami communicantes are composed of very fine, medullated motor and sensory fibers which pass from the anterior primary divisions of certain spinal nerves (1st or 2nd thoracic to 2nd lumbar) to the gangliated cord. The visceral branches of the 2nd, 3rd, and 4th sacral nerves (pelvic splanchnics) correspond to the white rami although they do not join the gangliated cord but pass directly out to the prevertebral plexus. In this group are also included the visceral branches of the 3rd, 7th, 9th, 10th and 11th cranial nerves. The white rami contain medullated nerve fibers derived from both the anterior motor route (splanchnic efferent fibers) and the posterior sensory route (splanchnic afferent fibers). The cervical and lower lumbar nerves do not give off white rami. The cerebro-spinal fibers, as such, probably never actually gain the tissues of an organ, the last link in the pathway of connection being a sympathetic fiber.

Splanchnic efferent fibers are motor to the non-striated muscles of vessels and a portion of the rectum, inhibitory to the stomach and intestines, secretory to glandular tissues, and cardiac accelerator. **Somatic vasomotor, pilomotor** and **secretory fibers** course along with the white rami. **Splanchnic afferent fibers** are the axones of spinal ganglionic cells and course along with white rami. They run without interruption from the viscera to the posterior root ganglia. They are sensory fibers of the cranio-spinal type, collecting impulses in the domain of the sympathetic. **Afferent sympathetics** proper consist of fibers arising in the sympathetic ganglia which enter the spinal root ganglia by way of the rami communicantes and arborize around the cells of the spinal ganglia. It must be remembered that white rami are absent in the cervical area, due to the arrangement of visceral afferents in the upper thoracic.

The **gray rami communicantes** are bundles of axones of sympathetic neurons which pass from the gangliated cord to each one of the entire series of spinal nerves and are then distributed to the area supplied by these nerves, such as the skin, sweat glands, blood vessels and the arrectores pilorum muscles. Their origin from the gangliated cord is irregular. After joining the spinal nerve, the course of their fibers may be either

1. Along with its anterior or posterior primary divisions and convey vasomotor, pilomotor or secretory impulses to the involuntary structures of the somatic area; or
2. They may enter the spinal canal by way of the anterior or posterior nerve roots and supply the meninges and intrinsic blood vessels, but not the medulla itself. (Each gray ramus gives off a delicate recurrent or meningeal branch which goes to the interior of the canal).
3. Other filaments pass over the bodies of the vertebrae and supply the intercostal and lumbar arteries, the ligaments and the bones themselves.

The **branches of distribution** from the gangliated cord include somatic and visceral fibers. The former are the grey rami communicantes. The latter, or efferent rami, comprise the splanchnic efferents, both white and grey, and the white splanchnic afferents.

The **cervical sympathetics** contain both medullated and non-medullated fibers, a large portion of the former being of cranio-spinal origin. Where white rami are absent, therefore, visceral efferent fibers must enter the cord via white rami elsewhere, as is the case from the upper four or five thoracic nerves.

The thoracic portion receives most of the spinal fibers connected with the sympathetic system. It has both white and grey rami communicantes. It contains many types of nerve-fibers, the functions of a few of which are herein enumerated. It has vasoconstrictors to pulmonary vessels and the upper and lower limbs, secretory to sweat glands, pilomotor, viscero-inhibitory to stomach and intestines, vaso-

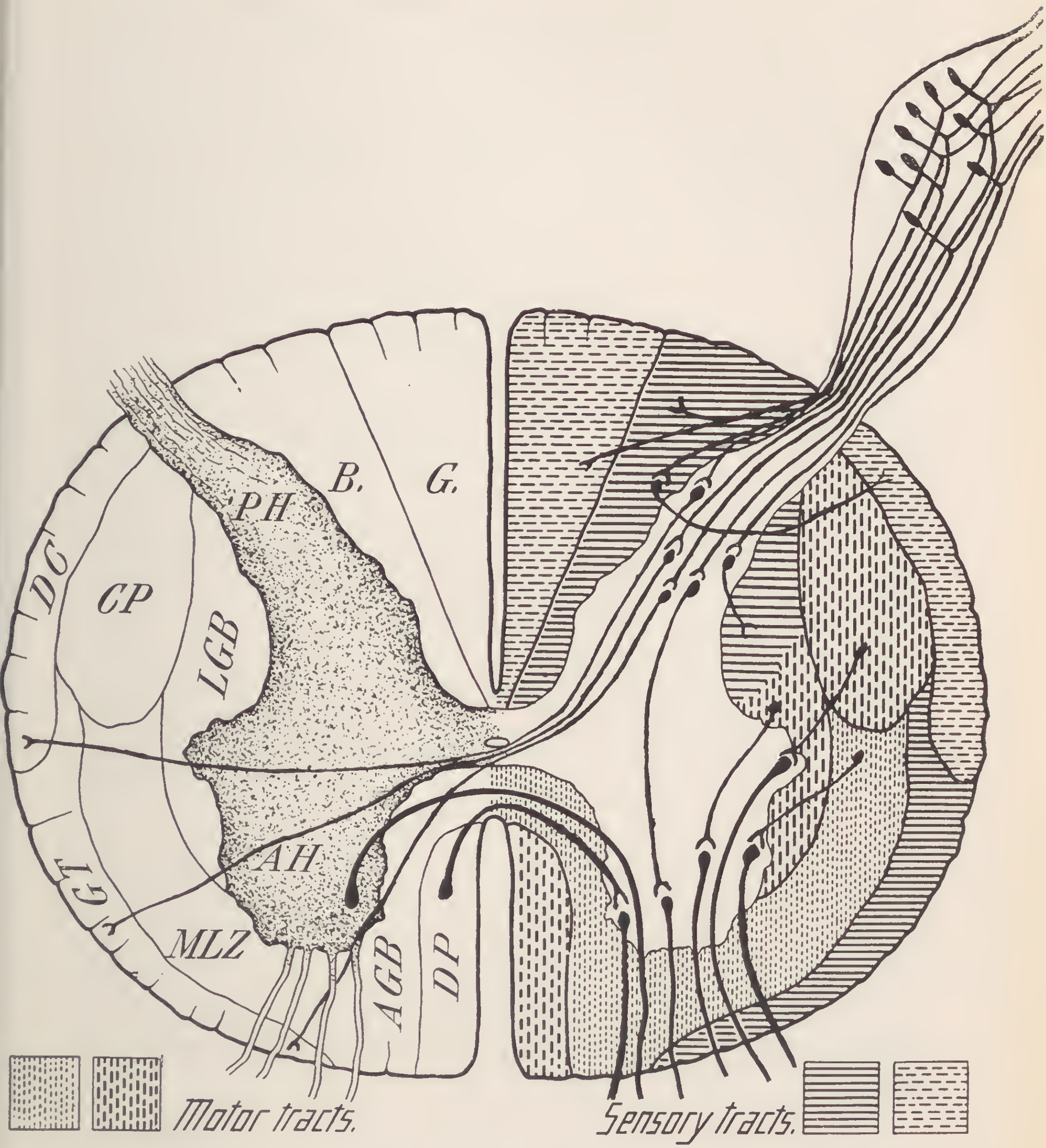
motor to abdominal vessels, sensory afferent fibers, motor fibers to the circular fibers of the rectum, and inhibitory fibers to the longitudinal muscles of the same.

The lumbar portion consists of spinal fibers which pass into the sympathetic by way of the one or two upper lumbar nerves, also receiving branches from the lower dorsal. It contains vasomotor nerves to the genitalia, and motor fibers to the bladder and uterus.

The sacral portion of the cord has no spinal fibers passing from the sacral nerves to the sympathetic chain, but the latter contains medullated fibers which descend from the lumbar region and terminate in the sacral ganglia. It gives off secretory, pilomotor, vasomotor, the chief motor fibers to the bladder and uterus and longitudinal musculature of the rectum, inhibitory fibers to the circular muscles of the rectum, vasodilator fibers to the penis and clitoris, secretory fibers to the prostate gland, and many others.

In cross section the spinal medulla presents, histologically, a variegated appearance. It is seen, macroscopically, to consist of white and gray nervous substance. The white matter is situated externally and constitutes the greater part of its bulk. The gray substance occupies the center and is so arranged as to present on the surface of the section two crescentic masses, placed one in each lateral half and joined by a transverse band, the gray commissure. Each crescentic mass has an anterior and a posterior horn. The latter is long and narrow and approaches the surface of the postero-lateral fissure, near which it presents a slight enlargement. The anterior horn is short and thick and does not quite reach the surface, but extends toward the point of attachment of the anterior roots of the nerves.

The following diagram graphically represents the transverse microscopic morphology of the medulla spinalis:



G. Column of Goll. *B.* Column of Burdach. *P.H.* Posterior Horn. *A.H.* Anterior Horn. *D.C.* Direct Cerebellar Tract. *C.P.* Crossed Pyramidal Tract. *L.G.B.* Lateral Ground Bundle. *G.T.* Gowers' Tract. *M.L.Z.* Mixed Lateral Zone. *A.G.B.* Anterior Ground Bundle. *D.P.* Direct Pyramidal Tract.

Cross section of the spinal cord showing anterior and posterior nerve roots, nervous connections and nerve tracts.

The Reflex Arc: The **somatic afferent neurons** send out two processes, one of which is physiologically dendritic and passes to the end-organs in the peripheral and visceral tissues associated with the same or adjacent segments. Afferent impulses are the carriers of scientific facts and collectively constitute the vehicle of motor control. The axonic processes continue into the spinal cord, forming for the most part its posterior roots. Around the cells of origin of these same nerves the dendritic portions of the cells of Dogiel may arborize, which, together with the posterior root fibers continue into the cord by way of the posterior root ganglia. Within the medulla these axones divide again, one branch passing upward in one or more of the long tracts (Goll or Burdach). The other may pass downward through several spinal segments by way of the lateral ground bundle and then, by means of its intrinsic cells, which are associative or commissural in function, re-enter at different levels after associating themselves with these levels. Certain of the fibers entering through the posterior root ganglia pass directly to the posterior root and arborize around the cells of Golgi, type II, which do not leave the confines of the grey matter. They constitute the simplest and most direct route by which connector nerve impulses of an afferent character are immediately transferred to efferent nerves in the ventral horn and spontaneously acted upon. Certain of the nerves entering the posterior horn of grey matter may arborize around the cells of Clark's column. It must be remembered that nerve reflexes carried over Golgi type II neurons are the simplest and quickest avenues of lower reflexive activity, and need not go out of their immediate segment.

Fibers which enter the long tracts carry afferent impulses upward to act upon, stimulate and correlate the centers in the cerebellum, pons, midbrain, thalami and cerebral cortex. As the long tracts end in the nucleus cuneatus and nucleus gracilis, they are further relayed and thus conscious-

ness is affected, probably by way of the fillet or lemniscus. The afferent fibers to the cerebellum come from a variety of sources. Their projection system, however, is largely through the cells of Purkinje and the dentate neucleus. These pathways are not simple, but complex, and they send in collateral and associative fibers which re-enter the grey matter in the cord and by means of many conduction paths co-ordinate many portions of the brain. This particular phase of the reflex arc cannot be dealt with at length.

Consciousness is affected only in the very outer layer of the cerebral cortex. The deeper layers of the pons, cerebellum and basal ganglia offer cross-paths and effect the mediation of reflexes, although consciousness may or may not be affected until after motor response has been initiated. Simple spinal reflexes give a single reply to a single demand. The reflex is a physiological answer. Afferent impulses through higher meditation are much more complex, for they co-ordinate and fill a physiological demand of an involved nature with appropriate responses in an entirely automatic manner. Sensory impulses acting through the cortex are subject to judgment and reason. They may be associated with emotional qualities, together with co-operative changes in respiration and circulation.

Certain complex reflexes are working constantly for the welfare of the body, as for instance, the kinetic static sense in the semi-circular canals. The minimum of afferent stimulus required to produce a primary sensory and secondary motor response is termed liminal intensity, or threshold stimulus. It varies from day to day according to variant circumstances. Nerve pathways, long disused, respond less quickly, as do those in which the resistance of the structures through which the stimuli must pass is greater than normal. Nerve tissue differs from other body tissues in that its potentiality is high, likewise its metabolic rate. It is the controlling system and easily thrown out of balance physiologically. Its electrical polarity and directive force is one way, with the exception of

some of the cranial nerves. Nerve cells are not easily fatigued but require a refractory rest period of approximately .003 of a second.

Abrami has proven experimentally that it is practically impossible to break the conductivity of nerve action along its axonic course. Artificial blocking of certain nerves, by anesthesia, shows that a nerve at its conclusion will evince practically unimpaired activity. Nerve impulses, then, tend to jump any minor obstacle along their course. Augmentation of this force increases as the stimulus passes, showing evidences of a re-establishment of energy outside of the cell body. Intiation of cell impulses, however, can come only through dendritic or receptor elements, and, hence, through a cell body. A nerve will tend to show normal capacity of constant intensity until an occasion arises which forces it to temporarily cease all activity. The weakest link, from the standpoint of conductivity, is the synapse. Constant bombardment at this point may weaken the contact to a degree that the receptor or dendritic action may become temporarily exhausted and the initial impulse cease. In this case, as, for example, the osteopathic lesion, the connector elements are most influenced. Initiation of various forms of incoordinate stimuli follow, besides those which the initial reaction produced. Dendritic bombardment, and resultant exhaustion of the synapsis lead to a complex disorganization. The cell of Dogiel carries, along with the nerves of the posterior root ganglion, disturbed impulses from the sympathetic to the cerebro-spinal system and is consequently a very important link in the production of what McKenzie calls his "viscero-motor reflex." This consists, in a general way, of the transference of effect from a disturbed sympathetic to a closely connected and intimately related sensorium. The question as to how this comes about can be brought out only in a general way, as the intricate working of a disordered nervous mechanism can manifest itself along many pathways.

The nearer a cell-station in the sympathetic system is to the ultimate axionic termination, the more local the disturbance and the more localized its effect upon the sensorium. This is especially true of the cranial output of the sympathetics. Ganglia act as distributing centers for a widespread dissemination of sympathetic impulses. Somatic nerves which are preganglionic in character give local, accurate reflexes; while automatic, postganglionic fibers give an immediate, generalized effect.

In order of sequence the author will assume an initial sympathetic disturbance resulting in irritative impulses which are relayed to the spinal cord, producing a viscero-motor reflex and through the operation of the laws of Head and Hilton, an osteopathic lesion perforce results. This is followed by edema of the cul-de-sac over the posterior root ganglion, which in turn produces still further disturbance and disorganization, particularly in the somatic afferent cells of the posterior root ganglion, including the cells of Dogiel. A widespread dissemination of cerebro-spinal and sympathetic impulses follows therefrom, with the accumulative result that all restraint and coordination of nerve impulses of the reflex mechanism are impaired, together with an extraneous development of harmful and unnecessary reflexes and an inhibition of others through exhaustion at the synapse. If more than one segment becomes involved, the disturbance becomes pluri-segmental.

If these irritative impulses persist over a sufficient period of time, they signify the beginnings of an osteopathic lesion, inasmuch as certain factors complicate the issue, factors which are not self-regulative. The viscero-motor reflex of McKenzie is nothing more than a somatic efferent and afferent expression of the spinal disturbance. Its visceral connection is well determined, although hidden: hence the osteopathic lesion in disease. If the lesion continues the pathology involves nervous structures. Nerve groups and the gray matter of the cord are subject to primary degeneration, a

form of dissolution in which the nutrition to the cells is progressively depleted.

Conscious sensations due to vertebral lesions vary greatly in their liminal values. These depend upon the nature of the subluxation, its time element and the psychic state of the individual. This threshold value is somewhat determined also by the type of circulatory disturbance present. During the active hyperemic state, or early congestive period, subliminal impulses may be perceived. In fact, they may become acutely troublesome. After the stage of inhibition, and when the circulation is in a more or less passive state, impressions are harder to receive over these afferent pathways, hence the liminal value is higher.

Two important basic laws previously mentioned are:

Head's Law—"When a painful stimulus is applied to a part of low sensibility in close central connection with a part of much greater sensibility, the pain produced is felt in the part of higher sensibility rather than in the part of lower sensibility to which the stimulus was actually applied."

Hilton's Law—"A nerve trunk which supplies any given joint also supplies the muscles which move the joint and the skin over the insertion of such muscles."

The Disturbed Reflex and the Production of of Symptoms: McKenzie says that all the symptoms on which a diagnosis is based are reflex in origin. In some, the reflexes are disturbed by the entrance of the stimuli through the nervous system and in others the disturbance operates through the circulation. To the former class belong the symptoms of such diseases as gastric ulcer, renal calculus and gall stones. The symptoms in infections are due to the disturbance of the reflexes through the circulation, as in influenza, malaria, typhoid and typhus fevers, measles and abscess formations apart from the swelling. In some diseases there is a mixture of both types, as in appendicitis where there is not only local tenderness and pain in the external body wall, with contraction of the muscles of the

abdomen, but the feeling of exhaustion, rapid pulse, and a tendency to vomit. In cholecystitis a similar complex is encountered. The need for more accurate identification of symptoms is seen when contemplation is had of the difficulty with which such seemingly simple affections are gastric ulcer and appendicitis are diagnosed. Although surgeons have been operating for these conditions for years, the most experienced find in many cases that they were mistaken in their diagnoses. This is in a great measure due to the fact that the precise nature and modus operandi of their symptoms have never been fully understood, and because those manifestations have never been clearly diffentiated from the signs of other diseases which resemble them.

It is undoubtedly true that every normal physical act which we perform during the daily course of our existence, as well as the vital activities of those organs over which we have no voluntary jurisdiction, is determined through the sphere of reflex activity. Many of these reflexes remain vague, misunderstood, and, to a great extent, unrecognized.

Every reactive force of the body, whether in health or disease, whether for the conduct of normal activity or those highly specialized protective functions demanded by varying emergencies, must carry out its individual duties in such a way as to preserve and perpetuate life and in such a manner that the organism will appreciate and meet every environmental variation. This disorganization and incoordination incident to the osteopathic lesion is a more or less harmful factor and constitutes a pernicious block to the carrying out of these vital activities. One authority has stated that a cancer is "cell metabolism gone mad." The same figure is appliable to the chaos and disorder of nerve impulses eminating from a segment adjacent to an osteopathic lesion.

(A. O. A. Journal, March, 1922—excerpts quoted from the Medical Times, 1921, by Dr. Henry Winsor.)

Sympathetic Segmental Disturbances: "The object of these necropsies was to determine whether any connection existed between minor curvatures of the spine on one hand, and diseased organs on the other. In fifty cadavers with disease in one hundred and thirty-nine organs, there was found curve of the vertebrae belonging to the same sympathetic segments as the diseased organs one hundred and twenty-eight times, leaving an apparent discrepancy of ten in which the vertebrae in curve belonged to an adjacent segment to that which should supply the diseased organ with sympathetic filaments. However, the nerve filaments entering the cord or leaving it travel or have traveled up or down the cord for a few segments, accounting for all of the apparent discrepancies. The check amounts to one hundred thirty-eight and when the one body, No. 12, which had a faint curve with slight pathology only, is added, we have the original, one hundred thirty-nine, showing that the figures are fairly accurate."

The original observations, omitted through lack of space, are now re-examined for discrepancies as a check system on the tables. Fifty cadavers exhibited a total of one hundred and five curvatures; two of which showed Pott's disease, two gross scoliosis, leaving one hundred and one minor pathological curves. Of these, ninety-six showed evidences of disorders (diseases) in some of the structures supplied by that portion of the sympathetic system coming from the vertebral segments in curvature. There were nine curvatures without any evidence of disease in the organs belonging to the same sympathetic segments as the vertebrae in curve. As four of these were gross curves, (Pott's disease or gross scoliosis) five minor curves are left without disease in the organs supplied by the same part of the sympathetic as the vertebrae in curve. Reversing the process of thought, two hundred and twenty-

one structures other than the spine were found diseased. Of these, two hundred were observed to belong to the same sympathetic segment as the vertebrae in curvature. Nine diseased organs belonged to different sympathetic segments from those of the vertebrae out of line. These figures cannot be expected to exactly coincide with those in the tables, for an organ may receive sympathetic filaments from several spinal segments and several organs may be supplied with sympathetic filaments from the same spinal segments.

In another series of twenty-five bodies, especially studied by the writer as to minor curvatures, spondylitis deformans, irritation of the sympathetic system and disease in the organs supplied by the same sympathetic nerve as the vertebrae affected, it was found:

1. That nearly every one of the twenty-five bodies showed rheumatoid arthritis, either of the heads of the ribs, of the intervertebral discs, or of the bodies of the vertebrae in curvature;

2. That rheumatoid arthritis was comparatively rare except in and around the vertebrae in curve;

3. That it was commonly found in the joints of the extremities;

4. That disease was nearly always found in the organs that were supplied by that part of the curvatures where there was rheumatoid arthritis;

5. That it was rare to find an organ diseased which was not supplied by the same sympathetic nerve as the vertebrae in curvature with rheumatoid arthritis thereon;

6. That the inflammatory exudate of rheumatoid arthritis of the ribs, discs and vertebral bodies involved in abnormal minor curvatures pressed directly upon that part of the sympathetic system related to the viscera found to be diseased;

7. That instead of passing to the diseased organs in a straight line the sympathetic nerves were stretched in an angular manner over this exudate;

8. That even where no bony exudate was found, there was an intense rigidity of segments, showing that fibrous or callous exudate could irritate the sympathetic.

Unfortunately it is impossible to accurately gauge the amount of disturbance resulting from the osteopathic lesion, which is not sufficiently stabilized to produce gross pathologic changes, but sufficiently disturbing to cause physiological imbalance. It is not, however, a far step into the realm of conjecture to assume their existence in the sphere of functional disease. The disordered reflex is sufficient proof of this.

Abdominal Pain of Sympathetic Origin is localized to the great ganglia associated with the organ or organs involved, but is not referable to the organ itself. If abdominal pain is elicited elsewhere it is significant of involvement of the parietal peritoneum. Hyperalgesia of the abdominal wall is found in nervous women without changes in the internal organs. This may be confirmed by pinching folds of the skin on either side and comparing findings, or by testing musculature by laying a hand over the painful area and requesting the patient to raise the upper part of the body, thereby causing contraction of the abdominal muscles. Pressure against the contracted muscles will elicit sharp pain. These two tests will confine the reactions to the skin and muscles.

Sympathetic pain is not as intense as that of the cerebrospinal system proper and it is usually more diffuse. It is further characterized by muscular contractures and circulatory and trophic disturbances; whereas involvement of the cerebro-spinal system is characterized by paralysis, impotence and more sharply defined pain. Neuralgia of the sympathetic system, causing both sensory and vasomotor disturbances, is essentially a neurosis and should be treated as such. Stajano speaks of a phrenic reaction in gynecology in which he found spontaneous pain and tenderness along the costal arch on both sides, with special intensity at the diaphragmatic point, particularly increased by force inspiration, signifying disease in the female genitalia. In cases of high blood pressure Pal claims that there is a sympathetic reflex due to arteriospasm

giving rise to cephalic pains. This is somewhat different from the symptoms of meningeal vasomotor disturbances associated with auto-intoxication, menstrual disorders, etc., wherein the pain is reflex. Idiopathic complexes of reflex disorders due to a general sensory overflow and secondary reflex developments, result in a systemic imbalance, and produce hyperirritability of the sensorium. This excessive afferent stimulation causes an excessive efferent irritation. Byron Robinson, in his explanation of visceral neuroses, states that the nervous system and the organs in the abdomen are not living in harmony. Moreover, if one organ is disturbed, it will tend to unbalance the remainder, indicating that irritation is reflected by a nerve arc from one viscus to another. This is pathologic physiology.

The Oculo-Cardiac Reflex (Aschner's): This is a slowing of the rhythm of the heart following compression of the eyeballs. A slowing of from five to thirteen beats per minute is normal; thirteen to fifty or more, exaggerated; and one to five, diminished. If ocular compression causes acceleration of the heart, the reflex is inverted. This test demonstrates whether or not the individual has normal coordinate activity of the vagus and vegetative nervous system; and, if abnormal, which predominates.

Vagotonia: This condition is caused either by hypertonia of the vagus or a hypotonia of the sympathetic (a substandard vegetative nervous system). Bradycardia of a more or less pronounced character is encountered in this condition when the above test is used. Such conditions as epilepsy, hypothyrodism, habitual constipation, asthma, gastric and duodenal ulcers, pylorospasm, hyperacidity, gout, urticaria, mucous colitis, hydrops of joints, constitutional disturbances characterized by fermentative purin metabolism, and others, are produced by this predominance of the vagus.

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Sympathet-icotonia: This condition is evidenced either by a hypotonia of the vagus, or a hypertonia of the sympathetic. Tachycardia of a more or less pronounced character is met with in this condition when the test is used. In other words, the test is inverted. Such conditions as hyperthyroidism, general paresis and tabes dorsalis are examples of this type of disordered nervous mechanism in which the sympathetic system predominates the vagus. Euziere and Margorot refer to apprehension and anxiety as characterized by extreme irritability of the sympathetic nervous system, and that this hypertonia is a constant physiological substratum of the psychical element of anxiety. In so-called functional neurosis Kempf states that uncompensated changes in the tension of unstriped muscle, and the special sense organs, act as the great etiological background for the production of these phenomena; and, that there is a continuous attempt on the part of the vegetative apparatus to neutralize autonomic tensions caused by the lack of equalization between a human dynamic factor and a universal opposing environmental force. Biological tension remains and must be neutralized if equilibrium of the body economy is to be restored and maintained. This has reference particularly to ungratified sex hunger, unfulfilled for social reasons. It is essentially a hypertonia of the sympathetic system.

The oculo-cardiac reflex is subject to so many individual variations that it is not a positive sign in differential diagnosis, but rather an indicator of probability. The centripetal path of the oculo-cardiac reflex is constituted exclusively by sensory branches of the trigeminal, and its centrifugal path mainly along the vagus and in some measure through the sympathetics. Complete antagonism is rare, as balance is easily upset by toxic or infectious processes and reflex disturbances. When inversion of the reflex is present, surgical operation is contraindicated because of the danger to the patient.

Inhibition and Stimulation: In a vast majority of cases or conditions these may be obtained only indirectly. In osteopathic therapeusis we are apt to use these terms indiscriminately, inasmuch as we employ, for instance, in the case of a patient in pain, inhibitory measures, and in the case of an individual in whom we wish to incite a physiological reaction, or re-awaken a dormant activity, stimulatory methods, without in either case having a clear conception of just what these terms imply. Take pylorospasm as an example: in this condition the objective of treatment is increased activity of the sympathetic control of the pylorus and the procedures employed are in no sense truly inhibitory. Again, in the case of a patient with chronic constipation, stimulation of peristalsis is the rational therapeutic aim. If, therefore, the sluggishness is due to hypertonicity of the sympathetic system, inhibition is in order.

Careless use of these terms leads to much confusion, for they have no specific indications in therapeusis, each case being a law unto itself. Hulett very concisely expresses this idea as follows:

1. "The necessity for stimulation presupposes an existing inhibition; and the removal of the cause of that inhibition constitutes the legitimate method of stimulation."
2. "The necessity for inhibition presupposes an existing stimulation; the removal of the cause of that stimulation constitutes the legitimate method of inhibition."

With but few exceptions it may be properly said that physicians should treat the lesion and let stimulation or inhibition take its own course.

"Find it; fix it; and leave it alone."---(A. T. Still.)

Exceptions are sometimes noted in which beneficial clinical results are obtained by the use of direct stimulation or inhibition. In a highly irritable lesion the corrective procedure must be carried out with the greatest care, to avoid mechan-

ical stimulation. In a chronic lesion of long standing, mechanical stimulation may result in increased activity, for the number of stimuli passing through a given segment may be greatly augmented in the same space of time merely by the degree of mechanical stimulation evoked. This in a measure explains the relative value of the use of these general physical reagents.

Causes of Disease: The etiologic factors in disease may be:

1. Physical.
2. Chemical.
3. Psychical.

All causes must be primarily external and secondary internal.

External causes may be:

Environmental and functional abuses.

Chemical causes may be:

Dietary, ingestion of drugs, alcoholism, etc.

Psychical causes may be:

Fear, anger, hatred, and worry; overuse, underuse of function.

All external causes must become internal before they can affect the human organism. The internal causes are likewise

1. Chemical.
2. Psychical.
3. Physical.

Chemical causes may be:

Faulty metabolism, i.e., lithemic diathesis, saline starvation or other acidosis, perversions of internal secretions.

Physical causes may be:

Osteopathic spinal lesions, displaced organs, posture, etc.

Psychical causes may be:

Reflex disturbances, etc.

The Germ Theory: The relationship between bacteria and disease is not clear on account of two factors:

1. The extreme variations in individual immunity;
2. The relative virulence of the germ.

However, science is fast proving that the germ itself as an entity is not wholly independent, but rather variably dependent on tissue devitalized by predisposing factors; but that the course and pathology of the disease is markedly influenced by the type of the invading organisms. Each type has its own particular manner and method of destructive activity. The toxin, rather than the bacterium itself, is the prime cause of tissue injury. Certain bacteria have a predilection for certain parts of the body. In fact, bacteria may be perfectly harmless in one portion of the body and highly pathogenic in another.

Dr. Still's Achievements and Contributions to Medicine: 1. The importance of structural states in disease; a better and broader outlook on disease, and its causes, particularly the latter.

2. The greatest contribution to therapeutics in the whole history of medicine, so stupendous and complete in character as to revolutionize the entire therapeutic world.

3. The first, best and only complete theory of natural immunity to be formulated; since proven by scientific investigation to be true. "The body itself contains within itself all the chemicals and all the medicines necessary for the cure of disease."---(Dr. A. T. Still.)

4. The fallacy of internal drug medication.

CHAPTER II.

THE OSTEOPATHIC SPINAL LESION

Etiology: To define all the causes of the osteopathic lesion would be impractical, other than to summarize them in a general manner.

(a) The vast majority of lesions are caused by reciprocal innervation through the medium of the reflex arc.

Some of the factors causing these reflexive phenomena are as follows:

1. Psychic (fear, anger, hatred, and worry.)
2. Orifical (adenoids, hemorrhoids, fistulae, impacted molars, hooded clitoris, phimosis, etc.)
3. Environmental (poor hygiene or sanitation.)
4. Functional (misuse, overuse, or underuse of function.)
5. Thermal (exposure to extremes of heat or cold.)
6. Chemical (drugs, ptomaines, faulty dietetics, etc.)

Broadly speaking, reciprocal innervation may be due to a multitude of physical, chemical, or psychical irritative disturbances. Moreover it may be intimately connected with any of the following classifications:

(b) Postural defects---disturbance of the centers of gravity.

1. Heredity (inherent weaknesses as congenital luxations, etc.)

3. Habit (faulty posture, sitting and standing, etc.)

3. Occupation (postural anomalies, as found in shoemakers, tailors, painters, violinists, etc.)

4. Secondary acquisitions (certain diseases, such as tuberculosis, infantile paralysis, obesity, and conditions such as flat feet, abdominal obesity, fractures, etc.)

Postural defects may be in the form of lordosis, scolosis, or kyphosis.

(c) Toxemia (By way of the blood stream.)

1. Exogenous toxins (bacterial, chemical, and dietetical.)
2. Endogenous toxins (fatigue, faulty metabolism, such as, for example, acidosis from disturbed sugar tolerance.)

(d) Directly physical:

1. Trauma, (wrenches, falls, blows, etc.)

Pathology: (a) Gross changes.

1. Malposition or subluxation of the vertebra in lesion.
2. Unequal and imbalanced muscular tensions.
   (a) Contracture where there is approximation (hyper-tonic.)
   (b) Tension where there is separation (atonic.)
3. Ligamentous shortening and thickening occur concomitantly with muscular contracture.
   Lengthening and tension of ligaments occur coordinately with muscular tension.
4. Compression and decompression changes are found in the intervertebral disc.
5. Edema and induration of the surrounding tissues.

(b) Microscopic changes.

Edema and acidosis are present in the tissues surrounding the vertebra in lesion. Carbon dioxide tension is plus, and oxygen tension is minus. Other end-products of cellular metabolism are present. This is principally due to circulatory disturbance, inasmuch as the circulation to the cord is markedly influenced by pressure. As the veins are more subject to compression than the arteries, the result is usually a congestion, rarely anemia. Circulatory interference in the cord is not only found in the segment corresponding to the vertebra in lesion, but may to a lesser degree disturb the segments above and below the lesion.

Low grade fibrositis of the connective tissue elements occurs, consisting of a hyperplasia and hypertrophy (largely hypertrophy.) Interstitial changes depend upon the chronicity of the lesion and the degree of catabolic toxemia present.

Muscular changes occur in the following order: 1. contracture; 2. congestion and capillary hemorrhage; 3. edema and acidosis. The acidosis is due to defective excretion of muscular catabolites, particularly carbonic and sarcolactic acid. 4. Low grade myositis with interstitial hypertrophy as a final result. Atrophy of muscle fibers follows. The small muscles adjacent to the vertebra in lesion suffer most. On palpation the tissues have an edematous, doughy feeling and the muscles and ligaments give the sensation of a corrugated whipcord.

Induration, thickening, and shortening of the ligaments occur concomitantly with muscle changes. Proliferative changes may ensue. In the chronic lesion, the ligamentous changes are more pronounced, while in the acute, the muscular contractures predominate.

Nerve pathology varies according to the type of the nerves and their situation. The sympathetic unmedullated nerve fibers are most affected. They may show a primary degeneration or worse. The nerve trunk may have a slightly thickened neurilemma, granular medullary sheath, and a slightly swollen axis cylinder. Inasmuch as trophic function depends upon the complete integrity of the entire reflex mechanism, it is easy to visualize the far-reaching effect of such nervous pathology. The visceral efferent and afferent nerves show particular pathology.

The synovial membranes are first congested and there is an increased output of synovial fluid; later the synovial membrane becomes thickened and roughened, and the output of synovia is decreased. The articular capsules are thickened, particularly on the side which rotates anteriorly. In an old

lesion, the joint changes are very similar to those of a rheumatoid arthritis.

Disturbed reflexes, worthy of mention are:

1. Cerebro-Spinal
   - (a) Motor
   - (b) Sensory
2. Sympathetic
   - (a) Vasomotor
   - (b) Viscero-motor
   - (c) Secretory

Vasomotor disturbances occur in both the immediate area of the lesion and in the viscus supplied by related nerves, but in the former the ratio of vasomotor incoordination is augmented in direct proportion to the pressure disturbance.

Symptoms and Diagnosis of the Spinal Lesion:

1. Malposition or subluxation of the vertebrae in lesion is noted.

2. Tenderness or hyperesthesia of the lesioned area, due to irritation from tissue toxemia and pressure edema is present.

It is less pronounced in chronic lesions than in acute.

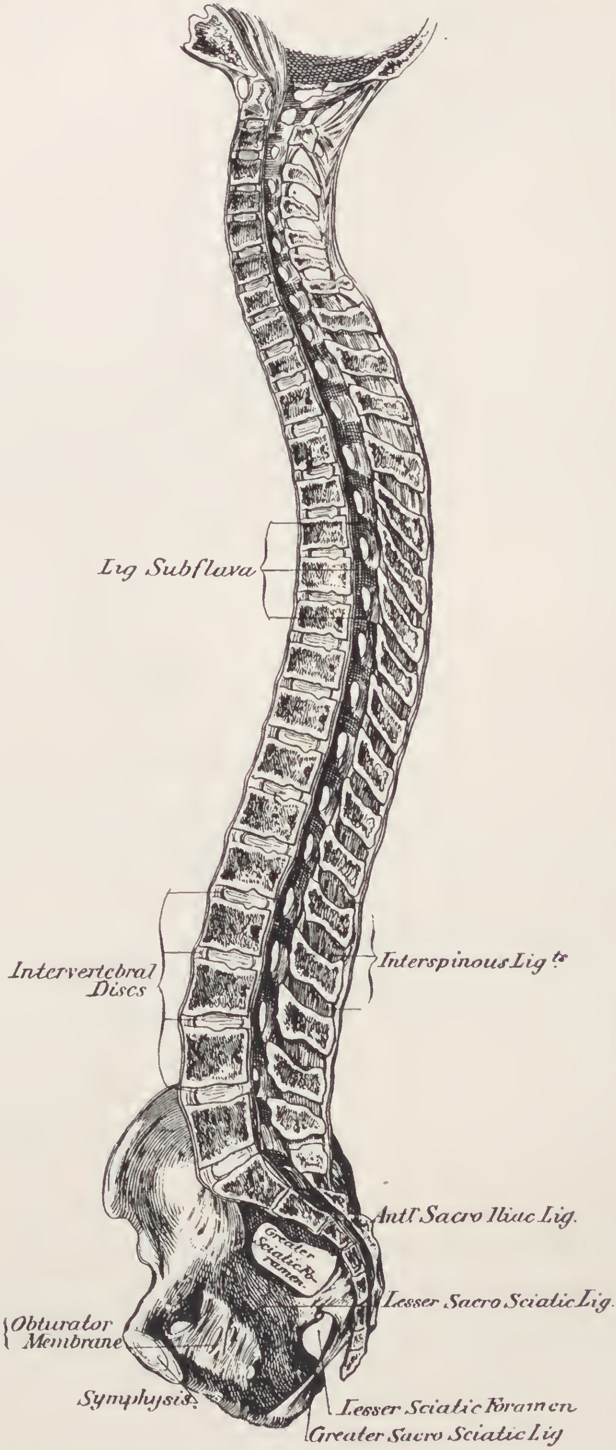
3. Restricted motion of vertebrae in lesion with those adjacent can be detected when physiological movement of that area of the spine is utilized.

4. A slight elevation of temperature is rarely found. It signifies a co-existent inflammation. The degree of surface temperature largely depends upon the acuteness of the underlying condition.

5. Disturbance of function in the parts supplied by the spinal segment influenced by lesion may or may not be obvious.

6. Referred pain (Head's law) is usually more pronounced in the acute lesion.

7. The position the patient assumes in relation to the existing structural anomaly is suggestive.



Sagittal section of the spinal column with ligaments.

8. Unequal muscular tension and soft tissue anomalies are easily palpable by reason of their corrugated, ropy and doughy feeling, respectively.

9. In the chronic lesion, pigmentary changes of the skin may be found around the involved area.

10. In a chronic, impacted lesion, there will be an area of hypermobility immediately above or below the lesion (compensatory).

11. The subjective symptoms and history may aid by directing the physician's attention to certain features, as for example, the history and character of trauma.

12. In acute lesions, muscular contracture predominates; while in chronic lesions, ligamentous thickening is ascendant.

Obstacles to overcome in the correction of a lesion:

1. The inertia of rest.
2. Contractured muscles.
3. Shortened and thickened ligaments.
4. Presence of rheumatoid arthritis, adhesions, ankylosis, etc.
5. The elimination, insofar as possible, of all factors concerned in the production of the lesion.

Force plus **velocity** correctly applied is essential to produce motion in any lesioned articulation. A certain amount is necessary to overcome the inertia of rest present. A still greater amount is needed when we stop to consider the hypertonic condition of muscles and ligaments in the lesioned area. If interstitial fibrosis of ligaments and muscles is present, still more force is required and repetition may be necessary---for example, the chronic spinal lesion.

We realize, last of all, that in the presence of too great a sum total of resistance, there is a limit to the amount of effectual force and velocity that can be safely used, as in

case of adhesions, ankylosis, etc. Certain other conditions indicate caution, not particularly because of the resistant phase, but more because of the underlying pathology, for example, rheumatoid arthritis. This is no contra-indication to adjustive treatment, other than that it should be directed at right angles to the planes of articulation to break fixation, rather than parallel to the planes of the articulation to restore pathway. It will then give nature an opportunity to restore partial normality to the articular surfaces wherein the second directive form of treatment given at the beginning would tend to increase irritation by the law of friction. Certain conditions, because of their underlying pathology, demand immobilization rather than mobilization, and should therefore be left strictly alone in a manipulative sense; for example, acute infectious arthritis, tuberculosis, etc.

The Principles of Technique: (I) Diagnosis, visualization, and analysis of the lesion are necessary. A positive diagnosis must first be made, following which the planes of articulation and the structural maladjustment must be thoroughly visualized. This having been done, analyzation of the mechanics of movement of the lesion can be made, and a definite technique evolved by which to retrace the pathway taken by the vertebra in lesion to its arthrodial limit; break the fixation, or otherwise conduct directive forces which ultimately have the readjustment of the vertebra in view. This is complete when a full range of arthrodial movement has been re-established—in other words, when mobility is complete. It also demands the reduction of any deep spasticity and imbalance of soft tissues which may react in such a way as to reproduce the lesion.

(II) Normalize soft tissues through manipulation and muscular relaxation.

Methods: (a) Approximation of attachments of muscles:

1. With manipulation of the belly of the muscle at right angles to the course of the fibers.

2. With steady, firm pressure.
3. Without pressure or manipulation.

(b) Separation of the attachments of muscles:

1. With manipulation of the belly of the muscle at right angles to the course of the fibers.
2. With firm, deep pressure.
3. Without manipulation or pressure.

(c) With neither approximation nor separation.

1. Firm, deep pressure.
2. Manipulation of belly of the muscle at right angles to the course of its fibers.

(d) Functional relaxation by active exercise.

Too much importance should not be attached to soft tissue manipulation for the osseous lesion is the main factor of clinical significance. Bony adjustment tends to break the vicious circle of reflex activity at its source, the spinal center in which or near which are the cells of origin of the nerves affected. Muscular contracture is, in the ordinary case, the result of continuously acting stimuli (providing it does not undergo interstitial changes), and osseous adjustment has the greatest effect upon the seat, or source, of the irritation. Muscular relaxation, however, is not only necessary to maintain bony adjustment, but is of value at times in the diagnosis of underlying bony lesions, as contractures sometimes prevent an absolutely satisfactory palpation of the osseous condition.

The operator should remember to make his soft tissue treatment soft and gentle in character. Abrupt and too vigorous manipulation, the stimulus of cold hands, over treatment, and hurting the patient are some of the factors to be guarded against. The best method to use depends entirely upon the condition at hand. To produce the best relaxation in the average case, use the approximation of the attachments with manipulation at right angles to the belly of the muscle.

Approximation of the attachments tends to produce physiological relaxation of the muscle by a removal of the tension. It is assumed that manipulation frees the circulation and promotes better drainage of the muscle, and, if correctly given, the benefits more than counteract the intramuscular stimulation naturally expected from knowledge of the fact that it is easier to stimulate than to inhibit. Approximation of the attachments of the muscle (spinal extension) with deep pressure is indicated in such conditions as excessive vomiting, diarrhea, hysteria, headache, gall stone colic, renal colic, lumbo-sacral pains in childbirth, etc. It modifies the irritative reflex impulses of a sensory character. It gives the patient great relief and is a good clinical example of what is termed inhibition. Active and passive exercises have their own particular fields, and will not be enlarged upon here.

The Taplin Table: Fills a great gap in our therapeutic needs. The author knows of no better method to reduce deep spastic tensions, and muscular and ligamentous imbalances, than by gradually increased, subtained, then gradually decreased, deep pressure covering the entire region of the lesion with the patient prone on the table and using the Taplin mobilizer. The period of sustained pressure should be approximatelv one minute. This will leave the lesion in better physiological repose after reduction and mobilization.

The Principles of Osseous Adjustment: 1. Reduce fixation by directing force at right angles to the planes of the articulations upon the transverse processes of the lower of the two vertebrae entering into the fixation. Arthrodial movement may not be desired at the time, other than physiological movement, which will tend to normalize arthrodial motion, and is compatible to the joint planes. If the first basic principle is not desired, then

2. Restore arthrodial movement by directing force against the vertebra in lesion to its full limit parallel to the planes of the articulation in the direction opposite to that of the fixation. This necessitates physiological locking or some form of anatomical locking.
3. Reduce fixation and restore arthrodial movement by combining both of the above principles.
4. Secure deep mobilization after the reduction of the lesion together with an elimination of deep tissue anomalies so as to leave the joint in the best physiological state possible.

Taplin chart with arrows indicating the direction at which force must be applied to be at right angles to the planes of the articulations.

Physiological Locking: Is not necessarily physiological movement as carried out by the individual dynamically, but rather the utilization of such a movement or series of movements as will tend to physiologically (articularly) lock the spine in the particular area and in the particular plane and direction in which the corrective force is to be applied. It is not a locking by forced tension of tissues. This principle may, or may not be taken advantage of, depending upon the type of technique used. It must not, however, be confused with physiological movement, as physiological movement is designed to give the greatest range of articular motion possible and reaches a point of limitation through forced tension of tissues rather than through articular locking. Physiological locking is designed rather to limit the possibility of excessive articular movement, that adjustive forces may in no way produce injury. Physiological movement carried to its full completion is, as has hereinbefore been mentioned, a forced locking by tissue tension. The capsular ligament is particularly strained thereby and if direct adjustive force is applied in the same direction in which the joint has been carried, it is apt to be torn or injured; whereas physiological locking carries the joint to a point of articular locking without undue strain on soft tissues.

In a general way physiological locking is obtained by primary side-bending and secondary reverse rotation.

Anatomical Locking: is just what the term implies. It is not a locking by the physiology of joint movement, as is physiological locking, but rather an enforced locking through some inherent or directly incidential anatomic factor. It may be the result of a certain definite physiological movement, or an anatomically applied fixation such as will tend to lock the spine for leverage, adjustive or protective purposes. It may be called upon in the use of certain specialized forms of adjustive technique.

Two particular examples of this type of locking are cited:

(1) Lumbar flexion---the degree of which will determine locking to any desired point in the lumbar column. It is an anatomical locking by forced tension for leverage purposes.

(2) Thoracic extension---This is an anatomical locking due to limitation, arrived at through the bony contact of the lower border of the inferior articular facets of the vertebra above against an indentation on the lamina of the vertebra below.

Osseous Technique May Be Divided Into Two General Classes:

(1) Direct action technique. This is a form of technique in which the entire adjustive force used is applied to some portion of the vertebra in lesion as the objective. There may or may not be preparatory physiological movement along the plane where the corrective force is to be applied for the purpose of locking adjacent vertebrae and creating counter-resistance above and below the lesion, that the corrective force may be effectual. Physiological locking is primarily protective. It is secondarily a locking and at the completion of the locking it becomes immediately and automatically transformed into leverage force. "Taking the slack out," is essentially an incorrect term, as forced tension of tissues will do that, without any obvious physiological locking.

(2) Indirect action technique: This is that form of technique in which the force of gravity, muscular leverages, resultant forces, anatomical locking or fixation above or below the lesion by means other than physiological locking are used.

Timing Adjustment:

The physician should adjust in such manner that he will catch the articulation unawares,---in other words, he should act at

the psychological moment when the patient is at the greatest point of relaxation. He should demand physiological relaxation by enforcing pacificity and partial relaxation on the part of the patient. The psychological value of a positive attitude on the part of the physician cannot be emphasized too greatly. The patient cannot assume anything but a negative attitude growing out of the mere fact that a passive and relaxed physical state is demanded of him. This gives the physician a tremendous advantage. He must dominate the patient and his own technique as well. It might be added that this pecular receptive state of the patient is not only of immense value to the physician in the application of his technique, but it opens a vast field for psycho-therapeutics and suggestive therapy.

The **objective** should be the point of greatest leverage on the vertebra in lesion. Avoid long leverages as much as possible, as they are awkward, faulty, and uncertain. Short leverages are specific and more easily controlled.

The point of contact is the anatomical part of the patient through which the corrective force is applied. It may be the transverse processes, spinous process, etc.

The instrumentality of force is that part of the physician's body through which the corrective force is applied. It may be the thumb, the pisiform bone, the hypothenar eminence, combined thumb and index finger, etc.

The **applied force** is the thrust. The velocity should be high, but the amplitude of motion slight.

The question will arise as to what form of technique to use. That depends upon the underlying pathology, the psychology of the patient and the objective to be gained. Many factors enter into its determination. The author has made it a rule to never utilize more than a certain amount of force and velocity, and never to the point of conscious hurt to the patient, or possible injury. The physician should have many

diverse forms of adjustment for the same lesion, making it possible to shift from one type of technique to another. No human agency can explain why certain forms of technique or types of adjustment will work very successfully in one case and not in another. It may be due to some peculiar structural variation in the patient. To reduce articular fixation demands a minimal amount of physical force. Assuming an articular facet of the spine in fixation, more or less glued tightly by exudative debris, it is easy to visualize that force directed parallel to the plane surfaces will necessarily need to be greater than that delivered laterally. As a matter of fact, force applied at right angles to the planes of the articulations must encounter a minimum of resistance. Indeed, much less force is necessary to accomplish a breaking of the fixation than in either of the two methods mentioned above. In the old, chronic lesion which is more or less subject to pathological changes, and generally unprepared to meet the emergency of joint mobility, due caution must be exercised. Its joint surfaces may be subject to a rheumatoid arthritis and arthrodial movement paralleled to the planes of the articulation, by the law of friction, will cause increased irritation and further pathology. Merely breaking the fixation, allowing nature to reassume her reparative function for a time before attempting to restore full arthrodial motion to the joint, is usually productive of better permanent results.

The Nature and Character of Arthritic and Rheumatoid Conditions: Inasmuch as these conditions are of considerable importance in handling joint pathology, they will be briefly discussed.

Etiology: It must be borne in mind at the outset that focal infection plays a role in relation to these conditions. However, too great emphasis should not be placed on what

has within the last few years become too radical a procedure in medical therapeusis.

Exposure to cold and wet, affecting the oxidative functions, as shown by the lowering of the dissociation curves of hemoglobin for oxygen, and concomitant decreased sugar tolerance are important factors.

Basal metabolism is usually lower than normal. The renal function will show a slight lag in elimination of water, salt and nitrogen; not sufficient to consider it causative but rather a more or less secondary disturbance. At best it acts only as a predisposing element.

Arthritis shows a lowering of sugar tolerance in direct proportion to the severity of the disease (high blood sugar). This is indicative of a disturbance of oxidative or combustive changes. It is the direct antithesis of diabetes in the matter of sugar metabolism; in fact, arthitis in this condition is very unusual.

The blood supply of the affected joints is inherently poor. In fact, they receive no blood to speak of and are almost entirely dependent upon synovial fluid, which lacks the active blood elements upon which nutrition and metabolism depend. This is easy to understand when we realize that the same volume of blood carries approximately forty times as much oxygen as plasma.

In gout the level of uric acid in the blood stream is high, as may also be noted in certain types of nephritis. Cereal gout is caused by too heavy a carbohydrate diet, (potatoes, cereals, etc.,) and is really a sugar intolerance rather than a true pathognomonic form. There is undoubtedly a nervous factor in gout; an imbalance between the sympathetic proper and the parasymphathetics. The purins, which are derived from nucleic acids, are converted into uric acid as an end product of metabolism. In the joint cavities of the gouty indi-

vidual there is a precipitation of fine, needle-like crystalline bodies consisting largely of sodium biurate.

The role of the internal secretions in these disorders, particularly those of the thyroid and suprarenals, is important because of their indirect control of oxidative powers; likewise the pituitary, by reason of its influence on sugar metabolism.

Treatment: Any factor which will cause a heightened rate of metabolism is of benefit. Osteopathic treatment should be directed to this end. Massage, hydrotherapy, heliotherapy, Bier's hyperemic treatment, exercise, fasting (being careful to avoid acidosis), taking pains to assure active eliminatory processes, vigorous passive movements of the joints in some cases, and supportive treatment for a time in others, are all valuable. Osteopathic treatment should be administered to secure an increase in the internal secretory functions of the suprarenals, thyroid and pituitary body. Certain authorities even go so far as to induce fever by injection methods so as to bring up the rapidity of the rate of metabolism. Because a joint surface may be partially destroyed is no contra-indication to vigorous passive movement, as this will reactuate natural processes which will tend to re-form a good functioning joint. A strict dietary reform is absolutely essential on the part of the patient.

Bony Landmarks of the Normal Spine:

1. **Cervical region.** Transverse process of the atlas is felt midway between the mastoid process and the angle of the jaw.
2. The spine of the axis is the first prominence below the occiput in the median line.
3. The spines of the third, fourth, and fifth cervical vertebrae are felt with the patient supine.
4. The sixth cervical spine feels like a small tubercle overlapping the seventh.

5. The spine of the seventh cervical (vertebra prominens) is easily felt but is sometimes confused with the spine of the first dorsal. Strong flexion of the cervical column causes forced flexion of the seventh cervical and brings its spine into greater prominence than it does the first dorsal. In the normal position the spine of the first dorsal is slightly more prominent.

   Place one finger transversely across the lower region of the back of the neck, bend back the cervical spine. The spinous process of the seventh cervical will be felt underneath the finger.

6. The transverse processes of the cervical vertebrae may be palpated as follows:

   (a) Posteriorly and to each side the posterior tubercles of the transverse processes can be felt.

   (b) Anteriorly and to either side the anterior tubercles of the transverse processes can be felt by pushing back the belly of sterno-cleido-mastoid muscle.

Thoracic Region: 1. The transverse processes of the thoracic vertebrae are situated at the level of the spine above and about one inch to the side.

2. The first thoracic spine is the most prominent in the region.

3. The spine of the third thoracic is on a line drawn through the roots of the spines of the scapulae.

4. The spine of the seventh thoracic is on a line drawn through the inferior angles of the scapulae.

5. The eleventh thoracic vertebra is considered as the middle of the spine.

6. The dorso-lumbar and cervico-thoracic junctions are weak points of the spine because they are the dividing points for muscular origins and insertions.

Lumbar Region: 1. The first lumbar spine is on a level with a point an inch and a half below the ensiform cartilage (same level as pyloric orifice of the stomach.)

2. The third lumbar spine is usually on a level with the umbilicus.
3. The fourth lumbar spine is on the same level as the crests of the ilia.
4. The transverse processes of the lumbar vertebrae lie half an inch higher than the highest point of the same spine.

CHAPTER III.

THE VERTEBRAL COLUMN.

Each vertebra, excepting the atlas, is composed essentially of three parts; a body and two lateral portions. The vertebral column, including the sacrum and coccyx, is the sum aggregate of the vertebrae in natural order. The column protects the contents of the vertebral canal, affords attachments to important muscles, supports the head and serves to protect the viscera and furnishes points of attachment for their supporting structures.

The vertebral column increases in size from above downward and is pyramidal in form. Viewed from in front the superimposed bodies present three pyramids. The first is formed by the cervical vertebrae from the second to the seventh, inclusive. The bodies of the lumbar and lower nine thoracic vertbrae from another pyramid which is much longer. An intermediate one, short and inverted is formed by the first three dorsals. A fourth, which is also short and inverted, is formed by the sacrum and coccyx.

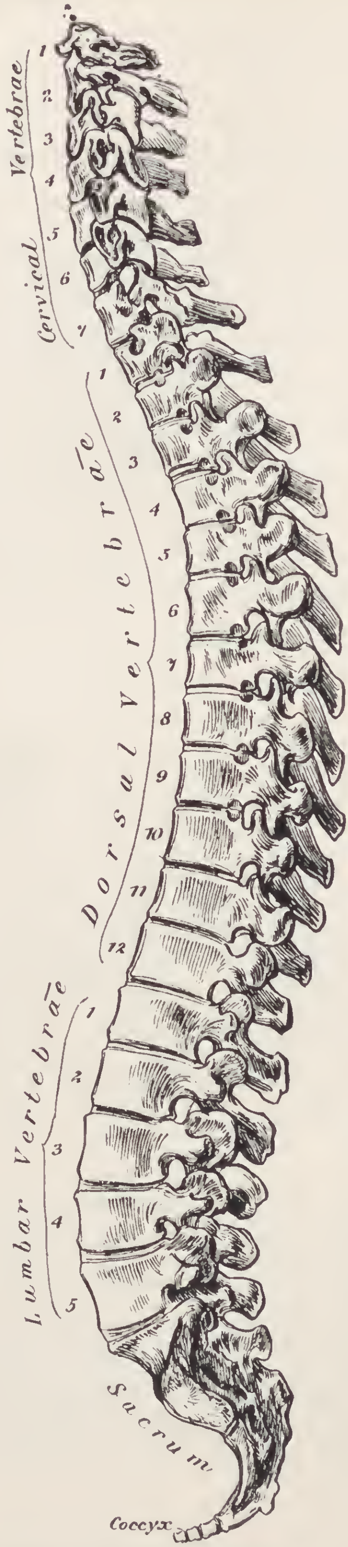
A profile view of the column presents four curves, two primary and two secondary. The first or cervical is convex anteriorly. The primary thoracic is much longer and larger and is convex posteriorly. The lumbar curve is convex anteriorly and ends abruptly at the sacro-vertebral angle. Last of all is the primary pelvic curve, which corresponds to the shape of the sacrum, and is convex posteriorly.

Dorsally the column presents a median and two lateral rows of processes. The median row comprises the spinous processes and the lateral rows the transverse processes.

Functionally the mechanics of the vertebrae conform to three demands. They must adapt themselves so as to support the head, present motion between their individual segments and allow for group motion. The head rests directly upon

the lateral portions of the atlas and the weight is conveyed through the occipital condyles to the lateral portions of the atlas. The weight is then conveyed through the superior articular processes to the bodies of the vertebrae with the exception of a portion which is deflected to the lateral masses of the remaining cervical vertebrae and through them to the bodies of the dorsal and lumbar segments. Thus there are two perpendicular weight lines in the cervical column: one directly through the superior articular facets of the axis to the bodies of the vertebrae; and another passing downward from the same point through the columniform articular region of the cervical vertebrae to the dorsal region, where it merges with its fellow to pass through the bodies of the vertebrae which now sustain the weight of the superincumbent mass. Although the spinal column proper is subdivided into three subordinate pyramids, the whole column, in a general way presents a cone, whose base is somewhat more than double the diameter of its apex. This disposition of parts gives rise to a structure of great strength and which is well adapted to the special demands made upon it. The degree of motion between any two vertebrae is great importance in the study of the mechanics of the vertebral column as any indisposition of one segment leads to disruption and incoordination of the whole.

Group movement is dependent upon and proportionate to the special demands made upon it. Pressure and traction can mould the bodies, the intervertebral discs, and the articular processes to any desired shape, so that the correlation of the weight of the body and muscular action may cause the vertebral column to assume one of a number of curvatures, if these forces are abnormal. This is a matter of accommodation to the forces mentioned.



Profile of a normal spine.

Equilibrium: The efforts of an individual to maintain the upright position and balance himself resolves itself into the maintenance of an antero posterior and a lateral equilibrium. Having assumed bipedism, man's weight falls through the long axis of the spine, which is at right angles to that for which it is mechanically best adapted. The added difficulties for maintenance of the erect position can be well demonstrated by Ashmore's table, giving a com-resolves itself into the maintenance of an antero-posterior with that of the human.

	Quadruped.	**Man.**
Spine	Horizontal	Upright
Support	Four limbs	Two limbs
Base	Large	Small
Superstructure	Low	High
Mass supported	Moderate	Large
Thorax	Swung between supports	Disposed in line of weight
Inspiration	Ribs fall into expansion	Ribs pulled up and thorax expanded
Expiration	Ribs pulled up	Ribs fall
Viscera carried	At right angles	In long axis
Muscular effort necessary to maintain balance	Small	Great

Antero-Posterior Equilibrium: The weight of the head is borne on the condyles of the occiput and a perpendicular line let fall from this point should pass through at those points where the spinal curves merge into one another. This line should fall through the extreme anterior edge of the promontory of the sacrum and from this point through the astragaloscaphoid joint so that with the use of the least amount of muscular exertion the occiput and atlas lie vertically above the astragaloscaphoid joint. If any part of the skeleton lies in front of this perpendicular line, it must be counterbalanced by a deflection posteriorly of some other portion.

The foot is the primary base of support with the individual standing. A vertical line passing through the center

of gravity must fall within its base of support and maximum stability is assured if it falls midway between the anterior and posterior pillars of the foot constituted, respectively, by the heads of the first metatarsal bones anteriorly and the tuberosity of the calcaneus posteriorly. This point is the astragalo-scaphoid joint which is the highest level on the arch, immediately in front of the ankle joint, from which the weight is deflected anteriorly and posteriorly, respectively, to the heads of the metatarsals and the calcaneus. In the normally erect posture the center of gravity falls slightly in front of the center of motion of the hip, the ankle and the knee joint. Hyper-extension of the hip joint is prevented by the iliofemoral ligament and hyper-extension of the knee by the posterior, lateral, and crucial ligaments. Muscular effort is required of the posterior cervical musculature to hold the head erect as the greater weight of the head is anterior to the condyles and the musculature of the back of the legs must contract slightly to prevent dorsiflexion of the ankle.

The curves of the spine are such that the first or cervical curve begins at the top of the odontoid process and terminates at the middle of the second dorsal vertebra. It has its convexity in front and forms eighteen degrees of a circle, whose radius measures six and five-eighths inches. Its most prominent anterior point is the forepart of the body of the fourth cervical vertebra. The second or thoracic curve begins at the middle of the second and terminates at the middle of the last dorsal vertebra. It has its concavity forward and forms forty-two degrees of a circle whose radius measures twelve and two-eighths inches. Its most prominent point posteriorly is the dorsal edge of the body of the seventh or eighth segment. The third or lumbar curve begins at the middle of the last dorsal and terminates at the lower end anterior edge of the last lumbar vertebra. It is convex anteriorly and forms eighty degrees of a circle whose radius is five and three-eighths inches. The fourth or pelvic curve, more acute than any of the others, begins at the upper edge of the sacrum and

terminates at the top of the coccyx. It forms one hundred twenty-five degrees of a circle whose radius is two and five-eighths inches. The degrees of curvature is not uniform, but is greatest a little below the middle. A direct line from the superincumbent weight of the head passes through the odontoid process and points of confluence of the spinal curves where they run into and support each other. It falls through the anterior edge of the promontory of the sacrum in its continuance downward. Normally this line passes in front of the fifth to the ninth vertebrae, inclusive, and consequently leaves the greater portion of the dorsal curve behind the line of gravity. Compensation for this deflection is provided for in the secondary cervical and lumbar curves, the directions of which are reversed.

If the line of gravity is disturbed antero-posteriorly, balance can be so disrupted and equilibrium become so unstable that it is lost. Gravity then predominates and the body will fall unless supported. This holds true if a perpendicular line through the center of gravity falls so far from the center of the arch of the foot as to pass forward or backward beyond this base of support. When the spine is partially involved a primary curve will result. It may be fully compensated for by a secondary one. Involvement of the lower limbs will ensue only if compensation is incomplete, in which case flexion or extension of the hips will be necessary to complete the compensation. If the primary condition is gross and the first two steps are not sufficient so that compensation is still incomplete, then the vertical line will not pass through the center of the base of support but in front or behind it, as the case may be.

No matter what the disturbing factor or factors, any agency or influence which directly or indirectly disrupts the architectural integrity of the vertebral column must of necessity be compensated for. If this does not occur the spine and its associated osseous elements will speedily cease to function mechanically, and equilibrium will thereafter be seriously impaired or lost entirely.

Arrows point out an eleventh dorsal vertebra immobilized in flexion. Spinal extension of the lower dorsal column is restricted, the postural equation is bad and associated gastro-intestinal disturbance and ptosis are present. This lesion is undoubtedly a responsible factor for the visceral condition.

In ordinary bending forward the anterior projection of the head and upper portion of the trunk in front of the center of gravity is counter-balanced by the increased posterior projection of the hips and lower portion of the trunk. The vertical line through the center of gravity cuts through the base of support and equilibrium is maintained. When the spine is extended the body inclines backward. Any considerable degree of extension at the hips is prevented by its ligamentous control and, if hyper-extension is great enough so that the center of gravity falls behind the base of support of the foot, equilibrium is lost and gravity predominates. If the body is inclined forward so that the vertical line through the center of gravity is in front of the base of support of the feet, then equilibrium is likewise lost.

When the hip joint is diseased flexion usually results as hyperextension is prevented by the iliofemoral ligament. The center of gravity is therefore forward. A secondary lordosis follows in the lumbar region. The knees may become flexed and if both compensations are not sufficient, added support in the nature of crutches may be used. Hyperflexion of the hip is common in coccyalgia and congenital luxations of the hip, causing incidentally an increase in the pelvic inclination. Increase in the dorsal curve or kyphosis, and increase of the lumbar curve, lordosis, are apt to be found together, one compensating the other. The etiology of this type of spine is usually confined to causative factors above the pelvis and does not involve the extremities. Lordosis is compensatory to prevent the center of gravity from going too far forward, and kyphosis prevents it from going too far backward.

Lateral Equilibrium: In the upright position the center of gravity falls midway between the ankles of the two feet. The fact that there are two points of support adds to stability. In standing, the weight is transmitted from the promontory of the sacrum to the

femoro-sacral arches with some deflection through the posterior sacro-iliac ligaments to the hip joint. It then passes downward through the long bones of the leg to the astragalus. Lateral equilibrium is maintained by muscular force except when symmetry is perfect or a position of rest assumed. Lateral movement is confined largely to the subastragaloid joint, which allows of lateral movement, and to the hip joint which allows of both abduction and adduction. A position of rest is possible in which there is lateral movement so that the center of gravity falls on one leg which is kept extended. This allows the opposite hip to descend and the leg to flex both at the hip and knee. This lateral movement is a position of rest and with the exception of a slight amount of muscular effort in the lumbar area and thigh, very little muscular energy is involved. The accommodation is mostly taken care of in the hips and in the position of the legs and its control is largely ligamentous. In lateral flexion of the spine a perpendicular line through the center of gravity shifts from the midline to the side toward which the trunk is inclined. To restore equilibrium the hips are inclined to the opposite side so that the center of gravity may be brought midway between the ankles. If the deviation of the lower part of the torso is compensated for by a deviation of the upper part to the opposite side, equilibrium will be stable from the pelvis down, providing the center of gravity is still in the midline. If the curve is double and confined to the spinal column, such as that found in organic curvature when the primary curve is completely counterbalanced by the secondary curve, there is no lateral shifting of the pelvis or shift at the mid-point between the ankles. If the primary curve is not completely compensated by the secondary curve there is a deflection of the pelvis and maybe some shift in the mid-point between the ankles. Shortening of one limb produces the same effect as the lengthening of the opposite one as it causes a pelvic tilt carrying the lower part of the spine with it, with the convexity of the lumbar curve toward the same side as that of the tilt. There may be a sec-

ondary compensatory curve above carrying back to the midline a double "S" curve.

A curvature which originates in the spine is not accompanied by tilting in the pelvis if spinal compensation is complete while the lateral curvature depending upon shortening of the leg is characterized by tilting of the pelvis. In lateral movement, if a perpendicular line passing through the center of gravity falls lateral to the midpoint between the ankles, equilibrium is unstable. If it falls outside of this base of support, equilibrium is lost and gravity predominates. This occurs providing the forces of counterbalance are not sufficient. Extra supportive measures may make up for its deficiency. A slight degree of lateral curvature, convexity toward the right, is found in the dorsal area in right handed individuals---due presumably to the greater use made of the right arm. Left handed individuals may show the opposite type of curve.

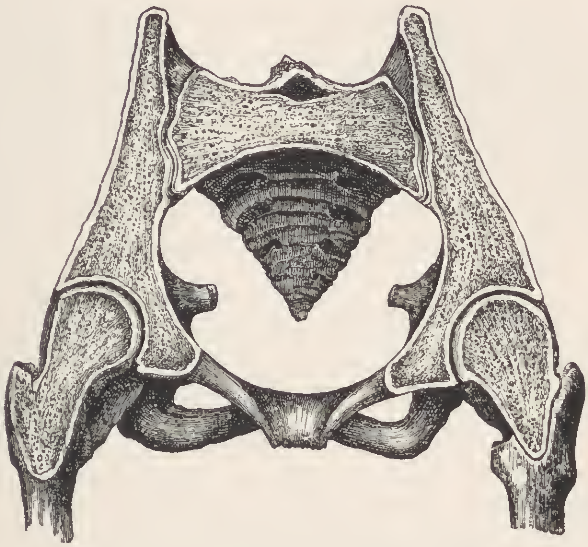
Balance: The spine is a curved, segmented, weight-bearing rod, balanced by muscular action and dependent upon a definite normal relation of the parts one to another. Balance is reflex and instinctively dependent upon the automatic correlation which exists between the muscular system and the mental sense of balance and equilibrium. The living individual is continually overcoming the positions induced by gravity by assuming the position of balance. The sense of equilibrium overcomes the force of gravity. Balance must be maintained both in the dynamic and the static state. When in motion the position of the bones is controlled largely by the muscles while at rest the bones are controlled by the ligaments. Whether in a state of motion or at rest the superincumbent weight is constant, although subject to rapid shifts as regards its points of bearing when the body is active. Due to the constant shifting of weight forces a continuous adjustment to a constantly varying position of the line of gravity is necessary. The nicety of balance and

equilibrium must not be lost, otherwise disability or deformity may result from the excessive points of strain and stress developed. Ligamentous stretching and weakening, muscular fatigue and impairment will secondarily develop and still further aggravate the disorder.

With the body erect the feet are the basis of support, with the pelvis acting as a secondary base; while in a sitting posture the pelvis is the sole basis of support. In the former the weight is transmitted from the base of the sacrum through to the acetabula, thence through the long bones, and in the latter to the tuberosities of the ischia.

The Pelvis: The pelvis is made up of two main arches which are known as femoro-sacral and ischio-sacral, and is further strengthened by two secondary arches which link up the extremities of the main arches still further to immobilize and strengthen them. The femoro-sacral arch passes upward from one hip joint crossing the middle of the sacrum, which is the keystone, and then passes downward to the opposite hip joint. The weight is transmitted through this arch with the patient standing, passing from the center of the base of the sacrum in a zigzag manner to the heads of the femora. From the sacrum it is first deflected downward and outward to the posterior sacro-iliac ligaments and then outward and forward to the heads of the femurs. The secondary strenghtening arch is formed by the rami and bodies of the pubic bones passing downward and anteriorly from one hip through the pubes upward and backward to the opposite hip joint.

The stability and structural integrity of this arch and its accessory reinforcement in front are dependent absolutely upon the sacro-iliac ligaments behind and the cartilaginous interval in the symphisis pubis in front.



Section of pelvis showing the suspensory action of the sacro-iliac ligaments.

The ischio-sacral arch passes upward from one tuberosity of the ischium through the sacrum, which is the keystone, down to the opposite tuberosity. This arch allows the superincumbent weight to be transmitted from the base of the sacrum through the ilia and bodies of the ischii to the tuberosities when the patient is sitting. The subsidiary strengthening arch passes forward from one tuberosity through its ramus and the descending ramus and body of the pubis through the symphysis pubis and on through the opposite ramus of the ischium to the tuberosity of the ischium of that side.

It is then obvious that the femoro-sacral and its subsidiary arch constitute a mechanical protection acting with the patient upright. The ischio-sacral and its secondary arch act when the patient is sitting.

The Nervous Mechanism of Balance: The cerebellum is the largest portion of the rhombencephalon. It lies in the inferior fossae of the occipital bone and is separated from the cerebrum by a fold of dura mater, the tentorium cerebelli. It is divided into two

hemispheres, connected by a central lobe, the vermiform process. It is composed of grey matter externally and white matter internally. The grey matter consists of four general types of cells found in three layers. From within outward the molecular layer contains stellate cells; the layer of Purkinje contains cells of Purkinje and Golgi type 2 neurons; the granular layer consisting of granule cells.

The white matter consists of the association and projection system; the association system connecting various regions of the cerebellar cortex, and the projection system connecting with certain structures in the cerebrum, pons, medulla and spinal cord. The afferent fibers come from a variety of sources, particularly through the dorsal spino-cerebellar fasciculus, (direct cerebellar tract), the superficial ventro-lateral spino-cerebellar fasciculus (Gower's tract) and perhaps from the spino-olivary nucleus.

The nuclei of the cerebellum are in the central core of white substance. There are four pairs, known as the dentate nucleus, the nucleus emboliformis, the nucleus globosus, and the nucleus fastigii. The ventral vestibulo-spino-fasciculus (Lowenthal's tract) is one of the main descending conduction paths for nerve connections for equilibrium in Dieter's, the vestibular nerve, and the nuclei fastigii in the cerebellum and medulla. A certain number of fibers pass down through the intermediate fasciculus or mixed lateral zone. The functions of the cerebellum are largely confined to the coordination and harmonizing of such muscular action as is necessary to maintain equilibrium during station or progression. All movements of this character are primarily volitional but from repetition gradually come to be performed independently of consciousness and are classified as acquired or secondary reflexes. It is therefore obvious that where the simple lower reflex arc is not sufficient for readjustment of the body position, a complex higher reflex arc is developed through the cerebellum and associated structures and that it does not

necessarily involve consciousness. A lesion of one hemisphere will cause lack of harmony and coordination for the opposite side of the body. Partial compensatory mechanism is located in the cord, pons, medulla and cerebrum. Disease will cause muscular tremors, vertigo, opisthotonos and pleurothotonus which make standing or walking difficult. The coordinating mechanism is largely reflex through its afferent connections with cutaneous, muscular, optic, vestibular and associated end-organs. They all indirectly connect with cerebellar structures. The efferent nerves indirectly connect with the general musculature of the body and mediate thereby such influences as are necessary to maintain equilibrium.

Lateral Curvature: Lateral curvature may be divided into two gross types: functional and organic. Organic curvature, or scoliosis, is a confirmed curvature maintained permanently in a position which no normal spine can assume. It may be congenital or acquired as malformation of bone from a congenital source may be a primary cause. Acquired organic curvature may be one of two varieties, the first being that type which is produced without passing through an intermediate postural stage, such as those associated with bone diseases like rachitis, etc., or muscular atrophy as in infantile paralysis. Those curvatures which pass through an intermediate postural stage, primarily belong to the functional type but later through neglect, poor treatment and resultant bony and soft tissue changes after a period of time become organic.

The **postural** or **functional curvature** is characterized by habitual inability to stand correctly. It is, moreover, capable of elimination ,which is not true of the structural type. It consists of a swerve to one side with only slight appreciable rotation of the bodies of the vertebrae. It is found most often from the eighth to the tenth dorsal with its greatest deviation at this point and the curve usually to the left. The functional movement which approaches nearest to that of organic curva-

ture is the flexion side-bending-rotation movement in the thoracic area in which the bodies of the vertebrae rotate toward the convexity. There is none of the deformity, however, which characterizes the organic scoliosis. With the exception of this functional movement all other functional curvatures are characterized by a rotation of the body of each vertebra toward the concavity of the curve in contradistinction to organic curvature in which the bodies of the vertebrae always rotate markedly to the convexity of the curve.

Wolff's Law: "Every change in the formation and function of the bones or of their function alone is followed by certain definite changes in their internal architecture and equally definite secondary alterations of their external conformation in accordance with mathematical laws. Plasticity of bone, particularly in children, implies structural changes in the vertebrae and adjacent structures."

Although a flexible straight rod can be bent either antero-posteriorly or laterally without torsion, a curved rod cannot be bent laterally without twisting or torsion and consequently all lateral curvatures are characterized by rotation of the bodies of the vertebrae to a greater or lesser degree, depending upon the nature and extent of that curvature.

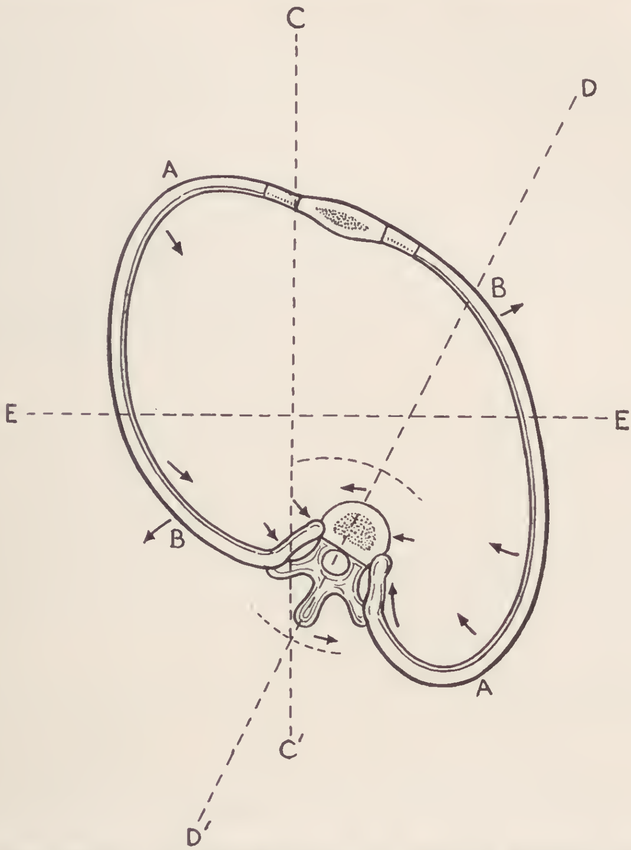
Organic Curvature: The mechanism of transition from functional to structural curvature may be summed up as the result of constant super-incumbent weight, and abnormal transmission of that weight with resultant weakening of the underlying structure. When the causative factor is muscular, traction is of importance, as for example, in infantile paralysis where one group of muscles is paralyzed and the pull of the opposite group unopposed. In children, where the bones are more or less plastic, the result of these abnormal points of weight bearing over a long period of time will lead to compressive changes in the bones themselves. If a

bone is diseased or abnormally plastic, as is the case in rachitis, its shape may be modified in a short space of time. The rapidly growing adolescent must accommodate himself to a very rapid shift in balance. This inherent instability leads to muscle-fatigue and muscle-fatigue to postural curvature which may develop into organic curvature, providing conditions are in accord. The age, sex, size, development, nutrition, and posture should be noted for their etiological significance and bearing on the condition. Joint pathology, abnormal muscular influences, fractures, luxations, adhesions, drainage, scars, etc., which cause alterations in the muscular or bony symmetry must be carefully noted. The general physical condition of the body and faulty habitual posture are indirect influences. The presence of diseased conditions must be carefully noted and their mechanical influence, if any, taken into consideration. A good example of such a diseased condition having a marked influence is empyema in which rib resection is followed by some collapse of that side of the thorax with marked adhesions, which is a direct mechanical force of disturbance. Chronic appendicitis may cause a child to bend toward the side of disturbance and curvature will result. In the indolent or rachitic child improper clothing, errors of refraction, defective hearing or some disturbing influence less gross in character may be sufficient to produce curvature of an organic type. Because of the structure and mechanism of the spinal column, this guiding influence is such that when the spine is laterally inclined torsion of the flexible rod must take place and with only one exception, that rotation is controlled in such manner that it must be toward the concavity of the curve. If the lateral inclination becomes constant the line of transmission of superincumbent weight is laterally deflected from its normal central situation, bringing abnormal stress upon the vertebrae involved. Muscles and ligaments become weakened by this persistent strain to which they are subjected. The effect is such that after compression

of the intervertebral discs and associated soft tissues, the bodies of the vertebrae attempt to rotate out from under the superincumbent weight and toward the convexity of the curve. Providing concomitant structural changes take place in the vertebral bodies, articular processes, intervertebral discs, the ribs, and associated soft tissues, permanent rotation of the bodies of the vertebrae away from the line of stress follows. This rotation is proportionate to the amount of structural change; and the rapidity of the process is dependent entirely upon the time required to provoke the structural changes. Scoliosis may vary in degree from slight asymmetry to pronounced distortion. The nature and amount of abnormal weight distribution will, by the character of its strain and stress, determine to a greater or lesser degree the transformation which the joints and bones must undergo. The deformity established is conpensatory for the changed position of the superincumbent weight and the altered transmission of its gravity line.

Further, it is a well established fact that a scoliotic spine may and usually does present a variety of clinical pictures in the course of years. Not only does the total curve very frequently change to a compound type, but in addition structural curves modify the body outline often by the addition of compensatory curves. Generally speaking, however, such later variations are but exaggerations of earlier structural abnormalties.

There is no hard and fast rule by which these changes come about. Each individual is a law unto himself. Every patient, therefore, must be examined and classified in the light of his own peculiar pathology and regarded from that standpoint alone.



Diagramatic representation of the changed position and contour of the ribs and vertebra in organic curvature.

The altered functional demands must be satisfied and the structural metamorphosis must, with the greatest economy of effort and materials, satisfy this intrinsic demand and yet afford a maximum of strength and stability.

The **scoliotic spine** shows characteristic structural changes. The bodies are wedge-shaped, particularly where the curve is the most acute, due to the marked compression on the postero-lateral border of the convex side. The spinous processes are deflected toward the concavity of the curve. The articular facets become altered in their directions and aspects according to the extent of the lateral deviation of the bodies of the vertebrae. In the lumbar area they may assume

a very oblique direction. In the dorsal area they may be so far depressed toward the abdominal cavity that they cannot be felt by external examination, while those on the convexity of the curve project backward and in very severe cases may rise approximately to the level of the apices of the spinous processes. In the dorsal area their crowding together results in an increased size of the articular processes on the side of the concavity and a decrease on the convex side. The deviation in the position of the transverse processes is extremely important from a diagnostic point of view and will enable the physician to diagnose a curvature in the lumbar region in cases where no lateral deviation of the spinous processes exists. The ligaments on the concave side are shortened and thickened and on the convex side are stretched, thinned and atrophied. The muscles of the back become atrophied from disuse, due to the rigidity and fixation associated with the curvature. This is particularly true on the convex side as secondary fibrotic changes frequently occur in the muscles on the concave side.

The angulation of the ribs is correspondingly changed. They are crowded together on the concave side with straightening of their angles but abnormal increase of the curves of their shafts, and with less obliquity of position. The ribs on the convex side are widely separated with a concomitant increase in the acuteness of their angles, with considerable posterior projection and with a lessening of the normal curves of the shafts.

Lumbar scoliosis presents less deformity, due principally to the fact that rotation is slight in the lumbar area. The changed contour of the waist-line, presence of an apparently larger hip, together with a series of palpably prominent transverse processes on the convex side is significant that lumbar curvature is present. Evidence of its organic nature can then easily be elicited.

Total scoliosis of an organic type is usually transitional

and is characterized by a high shoulder on the convex side with changes in the lower ribs; and it varies from the functional in that it is a confirmed deviation into deformity and not capable of total elimination.

Dorsal scoliosis is characterized by the greatest deformity. The line of spinous processes is not a true indicator as to the amount of rotation present in the vertebral bodies as the bodies in organic curvature move farther from the midline than do the spines.

The more common type of scoliosis is the **compound curvature.** In a period of years the total curve may change to the compound type. This is due to the fact that eventually the compensatory curve becomes organic. There are several clinical types and in probable frequency of occurence they are: compound, dorsolumbar, dorsal, total, lumbar and cervicodorsal.

The dangerous age for scoliosis is between 8 and 16 and the onset is insidious. Pain, if any, is localized in the back and is probably due to muscular and ligamentous strain. General symptoms are usually constant. The viscera, happily, can usually accommodate themselves to the alterations in the shape of the thorax and spine without any particularly noticeable disturbance. Possible pressure-effects exist and their consequences may be such as to cause pressure upon nerve fibers, lessen respiratory capacity, possibly displace the heart and crowd down upon the abdominal contents. The effect upon the ribs is such that occasionally anemia, of a costogenetic type, may secondarily develop. If marked muscular rigidity, abnormal temperature, localized tenderness, and the hot-water test are negative, the possibility of certain complications is thereby eliminated. X-ray shows the characteristic deformity. Rachitis must be ruled out as early as possible. This condition usually occurs between the ages of 4 and 6 and its onset is insidious. The child will give a rachitic history and characteristic anomalies may be noted.

Functional Curvature: Any prolonged alteration in the relationship normally existing between the axis of the shoulders and the axis of the hips is functional curvature, providing that curvature is capable of elimination. Functional curvature is an habitual inability to stand correctly and is a type of curvature which any normal spine can assume. It is a partial immobilization in lateral flexion or rotation. The etiological factors depend upon the maintenance of faulty posture, either occupational or habitual, particularly during the period of growth. It may result from anatomic deviations elsewhere, as follows: pelvic asymmetry, femoral inequality, with either Bryant's line or the shaft short, or both, pathologic variations of the vertebrae, or pathologic involvement of the extremities such as flat feet, diseases of the hip or knee, or of the soft parts. The most frequent curve is the long left lateral. In the purely functional scoliosis, pathologic involvement of the extremities or of the spine or pelvis is rarely concerned as they are usually accompanied by a structural curve. Flat foot is a common source of the functional type. The shortening of Bryant's line may be due to congenital or acquired dislocation of the hip, abnormality of position of the acetabulum, coxa vara from fractures of the neck of the femur and congenital and acquired anomalies of the angle of the neck of the femur. Slight shortening or lengthening of this line may also be due to slight subluxation of an innominate. Shortening of the line from the greater trochanter to the external malleolus may be due to shortening of the femoral shaft, excessive bowing of the tibia, shortening of both femur and tibia, or unusual size and development of the opposite trochanter.

Functional curvature occurs in all areas and is named according to the convexity of the curve and the area wherein found. It may be cervico-dorsal, dorsal, dorsal-lumbar or lumbar. It may be total postural, in which case it is a single curve and may be of sufficient length to involve both the

lumbar and dorsal areas through their greater extent. Transition to a double or organic "S" curve may follow.

Diagnosis of Lateral Curvature: Differential diagnosis between functional and organic curvatures may be summed up as follows:

Functional.	Organic.
No deformity.	Deformity.
Capable of elimination.	Not capable of elimination.
High side is upon the concavity of the curve.	High side is upon the convexity of the curve.

The procedure of examination should first include a thorough routine physical search for any obvious cause for scoliosis. A very careful history should be taken to ascertain the a priori relationship of early influences. The occupation should be carefully noted as well as the habits, posture and general functional conduct of the patient.

The respective levels of the shoulders and hips should be determined together with any lack of general symmetry in the body outline such as lateral displacement of the trunk, increased prominence of the hip or scapula. Notations should be made of any osteopathic spinal defects or sacro-iliac anomalies. Sacro-iliac subluxations should be noted if present before any attempt is made by measurement to ascertain the length of the lower extremities.

Measurement of the lower extremities should be conducted as follows: by first measuring the distance from the anterior superior spines to the internal malleoli and comparing them. Following this measure from the greater trochanters to the external malleoli. If inequality is present the first measurement indicates it and the second measurement determines whether it is below the greater trochanter or not. To still further substantiate the second finding, Bryant's line should also be determined, for by this means structural or pathological involvement and variation of position of the head and neck of the femur and acetabulum can be noted.

Determination should be made as to whether or not the curve disappears, is materially lessened, or is not changed with a support under one foot, or with the individual lying down and bent forward in flexion. If a curvature exists, the area of affection should be noted and the presence of a high side, whether upon the concavity or convexity. With the patient standing and a plumb-line erected from the cleft between the buttocks and the top of the spinal column, any lateral deviation of the spine can be noted as well as its associated structures, such as, for example, the relative distance of the scapulae from the sagittal plane.

Posture: Correct posture is a fundamental necessity for there is unquestionably an a priori relationship between postural defects that develop early in life and spinal and visceral disorders that sooner or later make their appearance. The physician of today, regardless of his school or specialty, should not neglect this important phase of human welfare.

The correct posture for both child and adult is to stand with the the head up, chin in, chest up and out, but not stiff or puffed out, shoulders up, abdomen in, legs straight and feet forward so that the body inclines forward slightly. The object of this bearing is to distribute the weight so as to effect the greatest economy of effort. MacDonald of Boston emphasizes that the individual, to obtain correct posture, must stand erect with an effort and at the same time have the arms and shoulders hanging loosely. He further adds that by attempting to "stand tall" one develops control and by this continuous efficiency determines his own expenditure of effort.

With the chest full, but not restricted, the dome of the diaphragm is high allowing plenty of space for the abdominal viscera and with no abnormal strain or tension of their intrinsic supportive tissues. With the abdomen in, effective support is supplied by the strong abdominal musculature. Conservation of energy is assured with the acquisition and

maintenance of correct posture. The body thus represents a highly efficient mechanism, capable of the greatest activity with the least expenditure of energy. By increasing resistance to bodily ills, it is an adjuvant source to natural immunity.

Bad posture is the opposite. The head is flexed, the shoulders stooped, the chest sagged down and narrowed, and the abdomen protrusive. In this type of postural defect lumbar lordosis follows and the knees become hyper-extended and the feet tend to pronate and flatten. The chest cavity is contracted and the dome of the diaphragm is lowered so that there is decreased space for the abdominal viscera, which are in turn pressed downward. The upright position under such circumstances is maintained only by constant muscular effort and this excessive muscular contracture affords a loop-hole through which much energy is lost. Defective posture is one of the greatest single factors, if not the greatest, for the production of excess muscular contraction. The end result of postural defect is muscle fatigue and circulatory congestion, both in the muscles and viscera. Activity upon the part of the child so afflicted will diminish reserve energy needed for developmental welfare.

The causes of postural anomalies may be divided into two groups: congenital and acquired. In the congenital causes are placed defects of development in children. The tall, slender child is particularly susceptible to postural defects and secondary visceral disorders as they usually have a long mesentery which adds to the tendency to visceroptosis. Children with lax or atonic muscles and loose joints are prone to bad posture. Under acquired causes come distortions of the lower extremities and pelvis, femoral inequality, knock-knees, bow-legs and pronated or flat feet. The end-result of these conditions is a tilting of the pelvis. An associated compensation for some of these conditions may produce a secondary lordosis, prominent abdomen, narrow chest, round shoulders,

etc. Occasionally scoliosis may be the end-result. There is an added tendency to ptosis by reason of the lack of abdominal muscular support and the associated strain and weakening of the intrinsic visceral supportive tissues. The symptomatology is characteristic and is based upon muscle-strain, fatigue and early gastro-intestinal symptoms. Muscle-strain and fatigue manifest themselves in leg, knee and foot ache and in a general feeling of fatigue and lassitude. Nervousness and irritibility, restlessness at night, lack of concentration, and poor scholastic progress are other characteristic symptoms.

The ptosed stomach and sagging, kinked intestines may produce a variety of symptoms as a result of improper and incomplete evâcuation of the stomach contents and because of the drag on the duodenum with partial blocking of drainage from the bile ducts. This will cause gastric attacks with nausea, vomiting and fever. The ptosed and kinked large intestine does not permit proper elimination of bowel contents and this leads finally to chronic constipation. The latter condition is followed by an associated intestinal toxemia and when the accumulative effect of this reaches a certain point, acute gastro-intestinal attacks take place. This type of toxemia more or less explains the reason for cyclic vomiting.

Malnutrition is usually marked and the child is frequently considerably under weight. Rachitis must be looked for as a large percentage of these cases either have a tendency toward or definite signs of rickets. Some authorities have called attention to the fact that there is an intolerance for fat in most of these cases and as it is a food element which is particularly important because of the nature of its vitamin content, and because of the relative prevalence of rickets it must not be overlooked. Diet is therefore a very important factor in the treatment. Functional albuminuria is frequently noted in children with lordosis and poor posture.

Fatigue is an inseparable companion to poor posture and

their inter-relation is such as to establish a vicious syndrome of cyclic activity, fatigue aggravating poor posture and poor posture aggravating fatigue. Another claim to excessive fatigue is the compensatory increase of neuro-muscular circuit-impulses necessary to maintain the upright position under such conditions. This leads to nerve-tire.

The treatment of these cases falls under three heads: diet, general care and correction of the underlying structural defects, and exercise. Osteopathic treatment is necessary for two reasons: first, to build up the patient's general physical tone and secondly to change the relation of parts which have a direct bearing on the postural defect and at the same time to rehabilitate the neuro-muscular mechanism which is connected with spinal muscular co-ordination. It is needless to say that imbalanced muscular tensions are consistent and constant associates of the spinal subluxation. Adjustment of the subluxation will abolish the abnormal reflex initiating this muscular contracture so that automatic control of spinal co-ordination will ensue. Renewed coordination of the spinal muscles without the continual conscious control of the patient is a distinctively osteopathic result of spinal adjustment. In correcting deformity, restriction of apparatus as much as possible is desired.

If rickets is present a diet with a high fat content and cod liver oil is indicated to promote the utilization of calcium.

Exercises should be carefully given, their object being to tone up and educate to proper action the musculature of the entire body. Special attention, however, should be paid to those muscles that preserve the erect position and work against gravity. The muscles which are most concerned in holding the erect position are the abdominal muscles, muscles of the shoulder girdle and the gluteal muscles. Exercise tolerance must be carefully noted; and in dealing with the child exercises at first should be given daily in recumbency.

At the end of two weeks the correct standing position should be taken up and the child instructed how to maintain it. Exercises with carefully timed periods of rest should be continued until the child can stand correctly without support. Instruction is given to the parents so that the less complicated exercises may be given at home. The child should report at intervals for examination and supervision should be maintained until results are apparently permanent.

In the adult caution should be exercised as regards ordinary calisthenics and gymnastic procedures. Special exercises should be designed for the special needs of the case. Exercise should be so given as never to interfere with the respiratory function and to strengthen the muscles involved. MacDonald of Boston advances reasons why the ordinary methods of physical culture have failed in many cases. He states that the ideal exercise is the one which automatically involves movement with unconscious cerebration. The initiatory process takes place in the lower reflex and is thereafter transmitted to the upper cerebellar neuron for mediation of control. He states that it is better to cultivate along the line of instinct as reliable for body-control, instead of the prevailing methods, which have failed because they are founded on volitional control of body-movements which should be automatic. Encourage exercise which does not have the object in mind of carefully scrutinized and performed volitional movement but rather which cultivates the animal instinct of unconscious cerebration, maintaining that exercise in a natural rather than an artificial sphere. Cultivate the animal instinct for stretching, complete relaxation and play.

There is more than a grain of truth in the above statements. There is no harder patient to deal with in the realm of functional disorders of the neuro-muscular mechanism than a gymnast, the individual who has placed in the sphere of conscious cerebration constantly scrutinized and volitionally controlled movements which would have been better left to automatic development. Such an individual cannot lose

sight of his neuro-muscular reactions and therefore limits his possibilities of relaxation, complete power over which is lost.

In a study of the neuro-muscular mechanism of equilibrium, we first note that there is a simple reflex, quick to intercept impulses and act upon them. This we term the lower neuron. Coordination, however, is dependent upon the upper neuron and without adequate upper neuron-control, impulses of the lower neuron can develop to any degree from tension to spasticity. There are two routes of impulses for mediation of control and coordination. One is through the cerebellar tracts to the cerebellum and the other through the cerebro-spinal tracts to the cerebrum. The latter is the tract of voluntary control and the former that of unconscious control, although both may work hand in hand. The more complicated the instruction and complex the movement, the less opportunity there is for automatic control and the greater is the conscious cerebration. If unhampered, the biological tendencies can assert control, and the individual should not consciously build up obstacles to the unconscious working of a perfect neuro-muscular mechanism which he can only imperfectly duplicate and, at best, only interfere with. Exercise must be handled in an intelligent fashion and from a neuro-muscular point of view.

Types of Functional Curvature: Functional curvatures may be grossly divided into two types: those involving the antero-posterior equilibrium and those involving lateral equilibrium.

Antero-posterior curvatures may be such that the normal curves are accentuated. Such a type of curvature is characterized by lordosis of the lumbar and kyphosis of the dorsal areas. This sort of a condition leads to a symptom-complex with a history of backache and, in the older adults, there are occasional evidences of a rheumatic diathesis. The

curves are more pronounced in persons who exercise the body greatly and in those who are accustomed to carry weights on the head. It may be secondary to a flexion lesion of the sacrum or bilaterally posterior innominates. Congenital dislocation of the hips may be due to lordosis of the lumbar area and a frequently secondary dorsal kyphosis. In these cases the pelvic inclination will be greater. This line is drawn from the lumbo-sacral angle to the upper border of the symphysis pubis and represents the relation it bears to the horizon. The lumbo-sacral angle is more acute. In the sthenic type barrel-chest may be noted, while in the asthenic individual or one suffering with general muscular debility, round shoulders and sunken chest are usually present. Individuals suffering from this type of spine are usually clumsy, walk heavily and most generally complain of backache. The fatigue syndrome is usually pronounced and the individual may show neurotic tendencies. Endogenous toxemias, particularly in the form of a rheumatic diathesis, are commonly associated.

In the kyphotic spine the swerve is generally backward and the spine may be partially or considerably involved in this posterior curvature. This type of curvature is found in old men, where a flattening of the vertebral discs presents a curve from pressure. Rheumatic gout may cause this condition. The condition is such that the dorsal and lumbar spines usually form one convexity backward. This condition is physiologically a persistence of the infantile position. The cervical area may be carried into exaggerated extension. Atonicity of the extensors is particularly evident, the sacrum is usually in extension and the innominates are bilaterally anterior. The knees and hips are usually chronically flexed to compensate for the spinal defect. Careless and faulty position, both in sitting and standing, such as for example, the debutante slouch in young girls and the common slouching position while sitting, particularly of men sitting in the so-called "easy chair," over-weighting of the shoulders with heavy

Demonstrating, on the Halladay spine, dorsal flexion. It is interesting to note the considerably greater range of movement possible in flexion, in contradistinction to that of extension. It must be borne in mind, however, that the ribs limit any great degree of motion in either direction.

clothing, heavy pendulous breasts, too rapid growth, overwork, bad air and poor hygiene are factors which are responsible for such a condition.

The lordotic spine is apt to be compensatory to prevent the center of gravity going too far forward. This anterior curvature is concave forward and is sometimes known as "saddle back." It is often found in pregnant women and very fat men with "pot belly." Congenital dislocation of the hips will cause a secondary lordosis. Pseudo-hypertrophic paralysis will do the same.

Lythospondylosis or willowly spine is a hypermobile spine in which excessive mobility is the paramount feature. It is usually found in tall, slender young girls and boys and accompanied by poor muscular and ligamentous development. Functional curvature is apt to develop from its presence. Peculiar idiosyncrasies of the muscles with marked elasticity of their fiber-element and muscle-fibers, which are abnormally long, give the appearance of a long muscle with a decreased diameter of the belly. The ligaments are long and stringy. Such a condition is a developmental defect. In the treating of any such condition, exercise tolerance must be carefully checked up and resistant exercises should be given to build up the spinal musculature, keeping always well within their capacity.

Sterospondylosis is a chronic condition of the spine in which hypomobility is the paramount feature. It is usually associated with postural anomalies, and is commonly kyphotic in character. Chronic toxemia, either endogenous or exogenous, is frequently a positive feature. It is commonly associated with rheumatic and rheumatoid conditions, and occasionally with hypertension so that a mistaken diagnosis of arteriosclerosis may be made. Proof of this mistake is that after partial breaking up of this rigidity the blood pressure will immediately drop without the added aid of other therapeutic measures or a special dietary regimen. Treatment should be designed to remove the rigidity by deep mobilization. For this purpose use the Taplin table and mobilizing

apparatus. Passive stretching and forcible correction of the very rigid areas should be attempted, providing there is no bone pathology to contraindicate this procedure. Posture is usually involved and therefore these defects must be eliminated. Corrective gymnastics are indicated in some cases, supportive treatments in others. The physician should not neglect to examine for the presence of focal infections, rheumatic or gouty diatheses.

The straight spine is that type of spine in which the natural curves are decreased. There is straightening of both the dorsal and lumbar curves. Such a type of spine is usually associated with poor muscular development, and the patient suffers from the general effects of the postural disorder. Military training is particularly apt to develop this type of spine. It is especially prone to lateral swerves as the spine in these particular cases is inherently weak, although the deformity is very apt to be overlooked as it is not particularly obvious. The American youth is particularly prone to this postural defect, especially those whose physiques are not strongly developed.

In disturbances of antero-posterior equilibrium, the curvatures produced thereby are apt to be associated with scoliosis.

Fundamentals of treatment should consist as much as possible in overcoming the etiological factors. Careful osteopathic supervision and treatment and corrective gymnastics, if necessary, also supportive treatment are indicated. The etiology demands a complete analysis of the patient's mode of living, personal hygiene and sanitation, diet, occupation, habits, posture, hereditary and structural influences.

Corrective Exercises: The patient should first be instructed in the fundamental standing position. If possible the pelvis should be fixed during exercise, otherwise it acts as a free agent and movement be-

comes general and not specific. Fixation will enhance the value of exercise and there will not be any lost and ineffectual movements. Lovett advises the use of Bade's apparatus.

Exercise No. 1.---From the fundamental standing position the patient stretches the whole spine upward, keeping heels firm on the ground. With deep inspiration and concomitant elevation of the shoulder girdle the muscles which maintain the proper erect position, particularly the extensors, are called upon and the elevated fixed position of the shoulder-girdle maintains a fixed point for the pull of the inspiratory muscles. At the end of deep inspiration, expire and relax to the fundamental standing position. This exercise tends to produce a general stretching of the spine.

Exercise No. 2.---From the fundamental standing position the shoulders are raised as in Exercise No. 1. The patient inspires and bends the trunk forward to the horizontal position, maintaining the spine straight and the shoulders raised. Movement is confined to the hip joints. From this position he returns to the upright posture with the shoulders still raised and the spine straight and from this point relaxes to the fundamental standing position.

This movement has the corrective value of Exercise No. 1 and is a good extensor spinal exercise with the lumbar curve straightened. It is of value in cases with a tendency to exaggeration of the lumbar curve. It may be modified and strengthened by having the patient place the hands behind his neck with elbows held back as far as possible. This raises the center of gravity of the trunk and increases the power of the leverage effect.

Exercise No. 3.---From the fundamental standing position the patient flexes until the trunk is horizontal, the arms maintained at the sides and the elbows flexed. The hands are held together against the chest wall. Inspire and extend the arms upward beside the head. Describe a half circle with the arms outward and back to the sides of the body. Expire as

the arms return to position. This is a valuable means of strengthening the spinal extensors and overcoming flexible round shoulders.

Exercise No. 4.---The patient lies prone on the table with the spine straight. He then clasps his hands behind his back on a level with the lumbo-dorsal area. The elbows are flexed and the clasped hands rest against the spine. He forcibly hyperextends the torso, meanwhile extending the arms and elbows backward and keeping the hands interlocked. This exercise is especially adaptable to round shoulders and, by raising the center of gravity, tends to counteract kyphosis of the dorsal area. It may be reinforced by dumb-bells or other paraphernalia.

Exercise No. 5.---With the patient lying supine on the table and with the head, trunk and legs straight and the feet strapped, he attempts with his arms folded across the chest to rise to the sitting posture, with the spine stiff and not allowed to flex. After completing this first move he returns to the primary position in the same manner with the spine still stiff and the base of the head touching the table before the back. This effectually exercises all of the abdominal musculature.

Exercise No. 6.---The patient lies supine and a weight is placed at the head of the table. The patient extends his hands above his head, parallel to the torso. He grasps the weight and carries it up to right angles with the body and table. He then carries it back slowly to the table. This is of value when the general toning up of the spinal musculature of the dorsal area is desired.

Flexible types of curvature are best treated by gymnastics. Supportive or retentive measures, however, may be necessary to maintain the correct position between treatments. Resistant cases must be first made flexible by osteopathic measures, manual stretching, gymnastics, forcible correction and stretching in apparatus after which the condition

must be maintained in the improved position as would be the case in the flexible type. If the shoulders are held forward by contraction of the soft parts, forcible correction may be necessary. In the milder cases, postural re-education, simple gymnastics, and easy, passive stretching may be sufficient. In the more severe cases, after forcible correction, a jacket should be applied to maintain the improved position.

Abdominal support is occasionally necessary when the abdominal muscles are particularly lax and the gastro-intestinal disturbance correspondingly great. Support should be applied only long enough for the abdominal muscles to shorten and recover tone. They should be so applied that the pressure diminishes from below upward.

The use of supports should be limited to those cases in which the lax muscles and general asthenic state of the patient is such as to not enable them to hold the erect position between treatments. It is also necessary after forcible correction to retain what is gained as these resistant cases frequently cannot maintain improvement between treatments.

Treatment of Scoliosis: Organic or structural scoliosis presents the problem of first eliminating partially or completely the deformity and, secondly, of retaining the ground gained. The age, amount of deformity, special physical characteristics and the state of health of the individual patient are all factors which must be given careful attention. Remedial attention must be paid to the underlying causes to prevent scoliosis from becoming greater and to retain the advantages gained at the end of the treatment.

Treatment of the curvature itself depends upon whether or not any permanent advantage can be gained by forcible correction, although every effort should be made to prevent its further progress.

Ordinary gymnastics are usually more harmful than beneficial and should be used judiciously. The reason for this is that the spine is rendered more flexible and this breaks down nature's protective barrier. The splint-like rigidity and stiffening of the affected region, which is always associated with curvature, is a supportive measure and, if eliminated, the spine may readily sink into a worse position and the curve become increased, providing preventive measures are not invoked. The atrophy of spinal muscles present in scoliosis of the organic type is more or less dependent upon the rigidity which is a direct inhibitant to muscular development. Together with correct manipulative and supportive treatment, carefully regulated exercises are of value in the treatment of curative types of organic curvature as the increased flexibility facilitates muscular development. It must be always kept in mind, however, that flexibility must never be obtained unless the physician is sure that he can control it to a beneficial end.

E. G. Abbott offers a fundamental mechanical foundation for the correction of curvature. Many modifications have been brought out since but his fundamental principles have not been altered. Flexion of the spine is the keynote of the treatment as in this position the vertebrae are unlocked and side-bending-rotation is then possible. This latter movement will carry the bodies of the vertebrae to the convexity of the curve. They must, however, be maintained in this position until sufficient bony changes of a normal character have taken place to retain the advantage gained. Partial correction primarily is secured by placing the patient in an Abbott frame, applying bandages which can be pulled in various directions and thereafter applying a plaster of Paris jacket with proper paddings underneath. To do this, the patient lies in a hammock or canvas swing in the Abbott frame. The pelvis is immobilized by bandages made fast to the frame on the side of the convexity. The low shoulder is raised and the concavity lengthened by a bandage encircling the axilla and

attached to the head of the frame. Another bandage against the convex side of the curvature is made fast to the frame on the concave side. With the patient immobilized in the position of flexion in the hammock and by an additional pull exerted by the tightening of the bandage, partial correction results. Following this the patient is immobilized in a plaster of Paris case with pressure pads so applied as to secure rotation of the vertebra. The maximum degree of pressure is brought to bear upon the angles of the ribs on the convex side with counter-pressure over the ventral aspect of the ribs on the side of the concavity. Windows or openings are cut in the cast in the reverse position to that of the pressure points, or in other words, over the angles of the ribs posteriorly on the concave side, and diagonally across on the convex side anteriorly. This allows respiratory action to take place in such a way as to cause the ribs to regain their normal position and shape. Maintain the cast until such time as is necessary to obtain over-correction. This is accomplished by means of felt pads slipped under the jacket to increase the pressure over the desired points. After over-correction has been obtained, a celluloid or other supportive jacket is worn to maintain this readjustment and exercises are then indicated to restore muscle function. This treatment applies to those cases of scoliosis for which definite and permanent results can be obtained. The types most amenable to treatment are the simple forms, particularly those with total curvature. In **double scoliosis** each curve may be treated singly and independent of the other although the primary curve, which is usually the dorsal one, should be treated first, and the secondary or compensatory curve will disappear unless organic changes have taken place.

When combined with kyphosis the curvature is much harder to eliminate unless flexion can be obtained beyond that held in the curvature.

Osteopathic treatment should be assidously given with the purpose in mind of obtaining greater flexibility and of building up the general tone of the patient.

Pott's Disease: This condition, which was first described by Pott, is charactesized by an angular curvature and is usually due to a tubercular infection of the vertebral bodies. Its onset is insidious and it most frequently attacks children, particularly between the ages of 4 and 6, who have a tubercular predisposition. There is, however, no age limit. It more frequently involves the dorso-lumbar region than any other Syphilis, cancer, acute osteomyelitis, exanthematous fever, or trauma are casual influences.

When tubercular, the intervertebral disc is usually first involved and is secondarily followed by a tuberculous osteitis. It may extend to other vertebrae or, more rarely, other portions of the same vertebra. The superincumbent weight bearing down upon the partially destroyed, softened and diseased vertebrae and discs produces the characteristic angular deformity. The patient is sickly and loses weight, is easily fatigued and very irritable. He complains of vague pains, usually referred to the anterior part of the abdomen. He walks in a peculiar manner in order to hold the back stiff and prevent motion. The affected area is very painful. Faradism or the hot water test causes pain. Muscular rigidity is excessive. There is a tendency to night cries and to secondary abscess development. Temperature is usually present although the rise is rarely over one degree. The deformity is characteristic and x-ray will show the focus of infection in the spine.

Treatment: Treatment consists of rest, plenty of fresh air and sunshine, a careful dietary regimen and special supportive apparatus to maintain immobilization of the affected region in a position of extension. Prolonged recumbency may be necessary to obtain satisfactory results as ambulatory treatment frequently fails. Albee's method of bone-transplantation is valuable and may be used as the results are quite uniformly satisfactory.

Spondylitis Deformans: This disease is an ostearthritis of the spine, characterized by excess bone formation causing the vertebrae to become ankylosed. The borders of the vertebral bodies are most frequently affected but any portion of a vertebra may be attacked. It may attack an individual at any age. There is usually a total kyphosis of the spinal column with persistent pain and tenderness. The amount of rigidity present is usually out of proportion to the amount of muscular rigidity. In fact, because of the pressure on the nerve roots, muscular atrophy frequently follows. The nerve involvement is frequently pronounced and may be such as to produce ascending degeneration of the cord.

Typhoid Spine: Typhoid spine is an aftermath of typhoid fever with tenderness of the spinal column and rigidity of the musculature. The patient is subject to periodic exacerbation of temperatures. The pain may be general or localized. It may be in the nature of a general aching or it may be such that it is felt only on motion, or both. Prognosis for recovery is good.

Neurasthenic Disturbances: A majority of authorities also describe certain border-line conditions which do not easily fall into any of the above classifications. Among them are to be noted the following:

Hysterical spine, encountered in hysterical individuals and characterized by a dull, chronic ache which is occasionally sharpened to pains of a neuralgic character. The entire dorsal area of the body, especially in and near to the midline, is markedly hyperesthetic. There is usually some noticeable lumbar deformity, and the thoracic spine may present a swerve as well. There may or may not be a history of trauma. Treatment is for the most part constitutional, although manipulation designed to overcome the deviation, if any, is also in order.

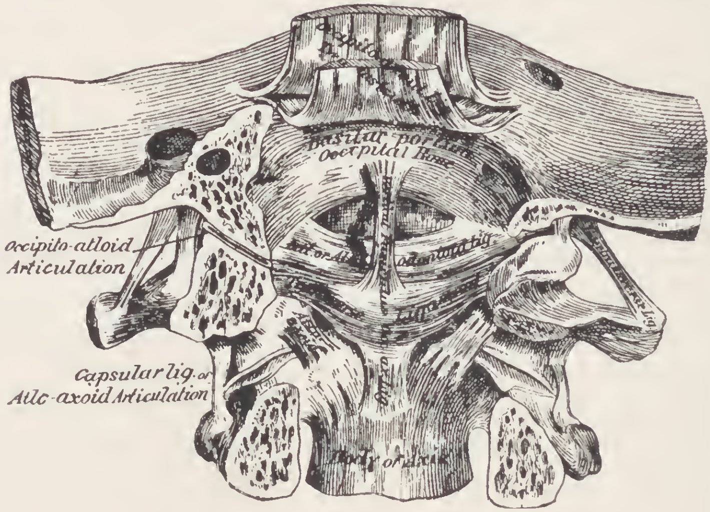
Neurotic spine resembles the above condition closely except that it is not complicated by hysteria. It occurs usually during adolescence and is most often encountered in females. The patient with such a spine complains of a constant, tired feeling and of a continual ache in the sub-occipital and lumbosacral regions. Occasional exacerbations of sharp, shooting neuralgias are also described. Physical examination discloses a distinct round-shouldered picture, and the entire spine appears atonic and weak. As in the preceding instance, treatment is for the most part constitutional. A general toning up is indicated and is secured by the employment of careful manipulative maneuvers, combined with a selected dietetic regimen and judicious exercise. Deep breathing is also distinctly valuable. It must always be borne in mind, however, that treatment is not local but general; and that, while relief may be given in a comparatively short period of time, complete recovery depends absolutely upon a restoration of nervous tone and balance throughout the entire body of the patient.

An **Aged Spine** is also mentioned by some authors. Its name is well-nigh sufficiently descriptive. It presents a more or less well marked rigidity with a varying degree of kyphosis, although the latter, for the most part, is characterized by stooped and rounded shoulders rather than by any great amount of exaggeration of the thoracic curve. Guarded traction, very carefully administered, is the therapeutic indication in this connection. Improvement is secured slowly, but is possible and fairly certain if persistence and patience are had.

CHAPTER IV.

OCCIPITO-ATLANTAL SUBLUXATIONS

The occipito-atlantal articulation is condyloid in character and composed of the superior articular facets of the



Section of the occipital bone, the atlas and the axis seen from behind, showing the articulation of the head with the atlas and the axis.

atlas together with the condyles of the occipital bone. The condyles of the latter are oval-shaped and their articular surfaces are convex from before backward and from side to side. They look downward, slightly forward and lateralward. The anterior extremities are directed slightly forward and medialward and therefore converge somewhat. The posterior extremities are on a level with the middle of the foramen magnum.

The superior articular facets of the lateral masses of the atlas are elongated, large, oval, concave depressions which approach each other anteriorly and diverge posteriorly. They

face upward, slightly medialward and backward to form fossae for the reception of the corresponding condyles of the occiput. The floor of each facet is deeper at each end with a slight elevation in the middle, the isthmus. The peculiar conformation of the atlas should not be overlooked, especially in that the atlas is without body or spinous processes, (the posterior tubercle excepted), but has larger lateral masses and prominent transverse processes.

The vertebral artery and suboccipital nerve (first cervical nerve) pass in the groove behind the superior articular facets. Important structures in front of the anterior arch and transverse process of the atlas are from within outward:

(1) Superior Cervical Ganglion.

(2) Internal Carotid Artery.

(3) 10th, 11th, and 12th Cranial nerves (Vagus, Spinal Accessory, and Hypoglossal.)

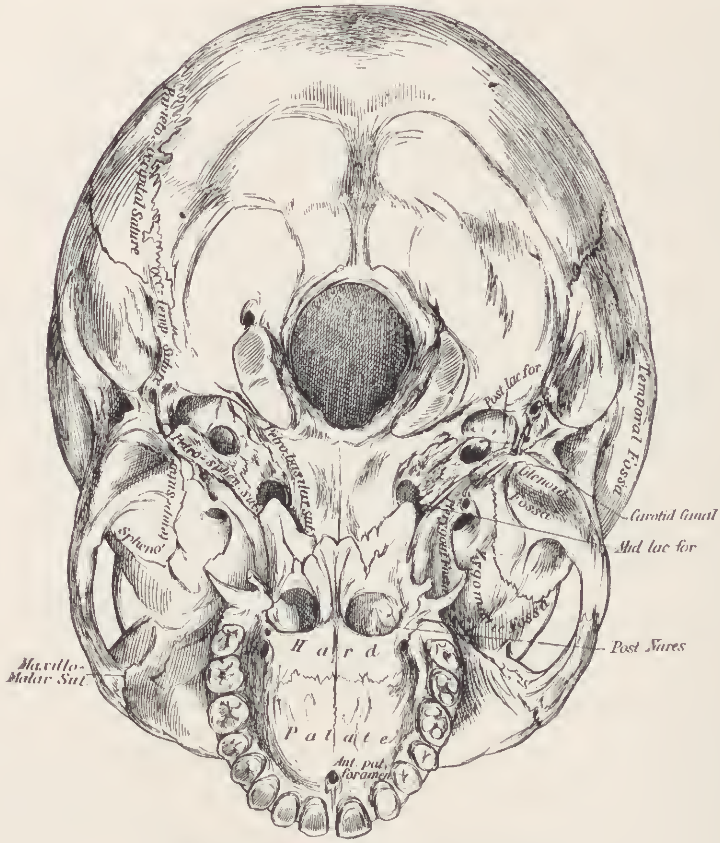
(4) Internal Jugular Vein.

Normal movements of the occipito-atlantal articulation are flexion, extension, side-bending or lateral flexion. Any appreciable degree of rotation is not essentially characteristic to this articulation.

Certain authorities point out that there are sexual differences of the atlas in that the lateral masses and their glenoid indices vary.

Lesions of the Occiput: There are eleven possible lesions of the atlanto-occipital joint. They are tabulated in the order of frequency of occurrence.

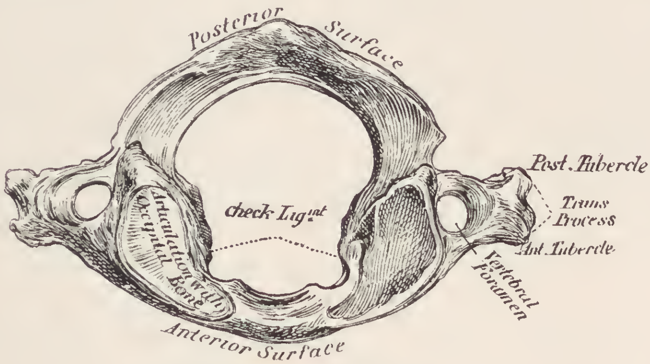
1. Unilaterally anterior occiput on the left (torsion lesion.)
2. Unilaterally anterior occiput on the right (torsion lesion.)



Base of the skull, external surface.

3. Bilateral anterior occiput (extension lesion.)
4. Left lateral occiput (side-bending lesion to the right.)
5. Right lateral occiput (side-bending lesion to the left.)
6. Bilaterally posterior occiput (flexion lesion.)
7. Unilateral anterior occiput on the left, posterior on right, (pseudo-rotation lesion.)
8. Unilateral anterior occiput on the right, posterior on left (pseudo-rotation lesion.)
9. Impacted occiput.
10. Unilateral posterior occiput on right, (torsion lesion.)

11. Unilaterally posterior occiput on left, (torsion lesion.)



Atlas seen from above.

The Anterior Grouping: By this designation is indicated those lesions in which either or both condyles are fixed in a relatively anterior position on the superior articular facets of the atlas. In this grouping are included both the unilateral anterior occiput on the right and left and the bilaterally anterior occiput.

Bilaterally Anterior Occiput: The bilaterally anterior occiput is an extension movement on a transverse axis, wherein the condyles of the occiput move bilaterally forward, upward and slightly outward on the superior articular facets of the atlas with subsequent immobilization in this position. The posterior extremities of the condyles are at a much lower level than the anterior.

Etiology: The question might arise as to why the greater frequency of lesions of the anterior grouping. It is perfectly obvious that from a functional point of view flexion is a much more abused factor than is extension. Whether or not the Darwinian hypothesis is true, it is not illogical to accept some conclusions deduced from Darwin's observations. No part of the human body shows greater inherent and faulty mechanical adaptability for the

upright position than the human spine. If it is assumed for the moment that in pre-evolutionary days, and when on "all fours," there was necessity for a much more powerful extensor grouping of muscles in the cervical area and the lessened necessity for that extremely powerful musculature, considering our present-day posture, it is easy to visualize the why of the extension lesion. The abuse of flexion is more than offset by the fact that the posterior cervical masculature is so much more powerful.

The lack of protection of the special senses of the face make the back of the head and suboccipital region more susceptible to trauma, wrenches, etc. Forced extension from the sudden starting of a car, unexpected stepping down from higher levels, etc., are good examples. Reflex contracture due to thermal exposure, drafts, etc., to the back of the neck is a common cause of lesion. It is associated sometimes with postural conditions, especially round shoulders and kyphosis of the dorsal area when compensation does not take place in the cervical region. (Cervical curve.) Functional abuse associated with occupational habitual posture necessitating long continued extension---for example painters and paper hangers.

Diagnosis: Sub-occipital contractures and tenderness are invariably present and bilateral in character. The head is held in extension with the chin pointing upward and forward, as this is the position which must be assumed in relation to the existing structural condition. The posterior arches of the atlas assume greater prominence posteriorly and are easily palpated. Restricted motion is greatest in the direction of flexion (apparently greater). The normal separation of the ramus of the mandible and the outer anterior portion of the transverse process is bilaterally increased, while a corresponding bilateral decrease, or approximation, occurs between the outer posterior portion of the transverse process and the tip of the mastoid process. The

tissues surrounding the tips of the transverse processes of the atlas are abnormally sensitive. It must be remembered, however, that they are more or less sensitive to pressure at all times. Disturbance of function and subjective symptoms vary. Referred pain (Head's law) often manifests itself in the form of occipital headaches, vague neurotic pains through the back of the head and neck and other sensory disturbances. If the lesion (occipital) is primary there is a secondary accentuation of the cervical curve as is also the case when the extensions are in a hypertonic state. If the occipital lesion is secondary there is usually straightening of the cervical curve, as an a-priori compensatory relationship exists between the two.

Treatment: If necessary, relax the suboccipital and posterior cervical musculature, previous to and following adjustment. Inasmuch as bony subluxation is reduced unilaterally by correcting one side at a time, the technique for adjustment will be given under adjustment of the unilateral lesion.

The Unilateral Anterior Occiput: The **unilateral anterior occiput** is a torsion lesion. It must be remembered that in normal movement the occipito-atlantal articulation is on a transverse axis: furthermore, that any torsion movement partakes of the nature of rotation, a movement which to any considerable degree is abnormal to this joint. Any movement of a rotary character necessitates a vertical axis for rotation. Obviously the only portion of the occiput which could perforce act as this axis would be the vertically disposed condyle. If one condyle describes an arc of motion forward, its fellow, the opposite condyle must act as the pivotal point or axis for this movement. The movement on this side is in the nature of a screwing motion of the condyle of the occiput upon the articular facet of the atlas, thereby allowing the condyle of the lesion side to de-

scribe an arc of motion forward, upward, and slightly medialward, and become fixed at a slightly higher level. The peculiar mechanics of this lesion movement must be borne in mind as it is of extreme importance from an adjustive angle.

Etiology: **Trauma,** directly or indirectly transmitted, is a frequent cause, as for example, falls, wrenches, etc. Suboccipital contractures may be unilateral; or if bilateral, the balance of muscle tension may not be equal in their hypertonic state, as one group may predominate over the other. It may be counterbalancing for some lesion lower in the spine which is disturbing the vertical line of gravity---as for example the "twisted" pelvis. It may be secondary to such conditions as faulty posture, lateral curvatures, unequal muscular tensions, ptosis of the upper eye lid, defective hearing in one ear, etc.

Diagnosis: Unequal muscular tension in the suboccipital area can usually be detected, together with suboccipital tenderness particularly upon the anterior or gross lesion side. The posterior arch of the atlas on the side of gross lesion will assume greater prominence posteriorly, due to the relative anterior position of the occiput on that side and the compensatory rotation posteriorly on that side of the atlas on the axis. Because of the fixed relationship of the occiput to the posterior arch of the atlas, any change in their relativity is the most accurate physical finding at our command. This finding can best be ascertained by comparing the posterior arches with the occiput above and with each other. No appreciable change will manifest itself on the side opposite that of gross lesion.

The normal separation between the end of the transverse process and the angle of the jaw is increased on the side of the gross lesion, while a corresponding decrease or approximation occurs between the end of the transverse process and the tip of the mastoid. The arc of motion on the opposite side to

that of gross lesion is so slight as to hardly produce any palpable change. The tissues surrounding the transverse process upon the side in gross lesion are usually abnormally sensitive. In this connection it is necessary to emphasize the point that too much importance must not be given to the relationship between the mastoid process with the angle of the jaw and the transverse process. It is a common cause of error in diagnosis for two reasons: first, that the transverse processes of the atlas are subject to many variations in size, shape, and position; these structural anomalies render it more or less inaccurate; second, the mastoid and the angle of the jaw are not fixed points, relatively speaking; hence we are dealing with variables. For probable diagnosis, they are of value and should be utilized as such; but diagnostic conclusions should depend, in the last analysis, upon the fixed relationship of the posterior arches of the atlas and the occiput.

The position the patient's head assumes in relation to the existing structural variation is suggestive. Supine, the head in relaxation assumes a slightly extended position and is tilted toward the side of gross lesion. Restricted motion is more evident on the side of lesion.

Principles of Adjustment for Lesions of the Anterior Grouping Using Occipital Leverage:

1. **Flexion:** As lesions of the anterior grouping are of the extension type, either unilateral or bilateral in character, flexion is the antithesis in joint movement. It should therefore be used, if possible, not only for that reason, but moreover because it places the condyle in better mechanical position to slide down the inclined plane of the superior articular facets of the atlas.

2. **Side-bending:** With side-bending is carried out two principles. It gaps the articulation that it is necessary to move; and, secondly, approximates the opposite articulation which it is desired to have act as a fixed-point axis for rotation by the laws of compression and friction.

3. **Fixation of the Arch of the Atlas:** It is necessary to oppose the direction of the corrective force of rotation by fixation of the arch of the atlas on the side toward which rotation is made. The reason for this is obvious---when it is considered that immediately below the occipito-atlantal articulation is the atlanto-axial articulation, constructed for rotation of the freest character. Rotation is the basis of the adjustment in a joint not normally constructed for that purpose and moreover in state of lesion when resistant forces are at their highest.

4. **Rotation:** The adjustment is completed with rotation. The bilateral lesion should be dealt with in the same manner as the unilateral, except that the procedure is carried out bilaterally instead of unilaterally. The reasons for so doing are indicated by an illustration. It is assumed that a heavy block of granite with a vertically disposed projection at either end is lying in an inverted position---this to resemble an occiput with its vertically disposed condyles. By applying leverage at one end, thereby describing a sufficient arc of motion, the block could be unilaterally replaced into a more anterior or posterior position. The side opposite to which the leverage was applied, would, through the increased compression, act as a fixed-point axis. Shifting the leverage to the opposite side the operative mechanics would be reversed and the opposite side moved to the desired point. This would constitute a bilateral adjustment. In other words---by shifting arcs and axes of motion the stone could be moved by one individual whereas it would take a group to move it en masse, either forward or backward. This illustrates the method of procedure in a bilateral anterior occiput. Using the procedure for a unilateral anterior occiput on the left followed by that for a unilateral anterior on the right, makes it possible to adjust a bilateral lesion with the greatest ease and efficiency. It is almost impossible to get sufficient favorable fixation below the point of lesion to make bilateral adjustment possible. It cannot be done without considerable strain upon the patient

and possibility of injury, as the operator is in nowise able to control accurately or focalize corrective forces.

Technique of Adjustment Using Occipital Leverage: For purposes of convenience and clarity of procedure the following hypothetical lesion is considered---an occiput unilaterally anterior on the left. The principles of adjustment as carried out in order would be as follows:

1. Flexion (easy flexion.)
2. Side-bending to the right.
3. Fixation of the arch of the atlas on the left.
4. Adjust with rotation of the occiput toward the left.

Technique 1. Patient supine. Operator flexes and side-bends occiput to the right, angle of side-bending approximately 15 degrees with the midline of the body. He then places left index finger, reinforced by middle finger, against the posterior arch of the atlas on the left. The left forearm and hand rest against the postero-lateral aspect of the head. The operator places the palmar aspect of right hand against the angle and ramus of the jaw on the right side. Keeping firm pressure against the atlas with the index finger re-inforcement, operator rotates occiput toward the left by directing right transverse force with left forearm, and left transverse force with right hand. (Do not disturb flexion and side-bending when completing adjustment.)

Technique 2. Patient sitting. The mechanical principles are the same as are used with patient supine. Operator stands at the side of the patient on the same side as the lesion he wishes to correct, flexes and side-bends occiput to the right to an angle of about 15 degrees with the mid-line of the body. The operator cups the patient's chin in the apex of the flexed left forearm, with the fingers of the same hand resting firmly upon the vertex of the head. The patient is instructed to lean

Position for adjustment of a unilaterally anterior occiput on the left using occipital leverage. Primary movement of flexion is followed by side-bending to the right to create by resultant compression a fixed point axis for rotation on that side. Arrow A indicates the posterior arch of the atlas on the left which must be firmly held to oppose the direction of the corrective force of rotation and retain the atlas as a stationary body. Arrow B indicates the direction of the corrective rotation.

against operator that he may relax better. The fleshy portion of the operator's right thumb is placed firmly against the posterior arch of the atlas on the left side. Maintaining firm fixation of the atlas, a rotary traction force is brought to bear upon the lesioned articulation by the proper coordinating action of the operator's left arm.

The author also utilizes other methods carrying out the same fundamental principles which cannot here be enlarged upon, (as the two mentioned are very specific and satisfactory), but instead the student's attention is drawn to an absolutely different mechanical basis for adjustment of the same lesion---not from the standpoint of occipital leverage, but rather from the standpoint of force directed to the atlas.

The success of this procedure depends upon speed and velocity. It lacks the nicety and mechanical advantage of occipital leverage, but is, however, a very satisfactory method if properly utilized. The author designates it a "column of blocks" technique. This is not a particularly good technical expression, but is appropriately expressive. For illustration, the student is here carried back to the heydey of childhood, when playing with blocks was an erudite task. Piling these blocks end on end the child would attempt to snap one of the under blocks from the column without disturbing the rest. This of course depends upon the degree of dexterity and the velocity used.

Now to regard the lesion from a slightly different mechanical view-point. The axis of motion passes vertically through the condyle on the side opposite the lesion. From the standpoint of the atlas---two lever handles are apparent---a long and a short lever handle. The short lever handle consists of that portion of the lateral mass and the transverse process of the atlas lateral on the right to the axis of movement. The long lever handle consists of all that portion of the atlas lateral on the left to the axis of movement. It must be remembered that the left condyle is not an axis for movement,

therefore the long lever handle will be all that portion of the atlas lateral to the right condyle. The right condyle, in an inverted sense, has a function corresponding very closely to that of the odontoid process in the atlanto-axial articulation.

Corrective forces must be directed against the long lever handles as the objective in this technique. Before attempting adjustment, however, it is necessary to carry out the following movements:

1. **Extension.** This physiological movement locks the lower cervical. Carry it to the degree sufficient to lock from below upward as far as the atlanto-axial articulation.

2. **Side-Bending Rotation:** A slight degree of side-bending toward the side of the lesion, rotation toward the side opposite the lesion (side-bending to the left, rotation to the right.) This should not be forced, as a stabilization locking of the cervical column (a stabilization locking is not a complete physiological locking) is desired. Extension of the lower cervical, and side-bending rotation of the upper cervical gives this locking. The degree of side-bending must be carefully watched (not over 4 or 5 degrees) as the operator wishes to retain the condyle on the right side as the fixed point axis.

3. Adjust by directing force anteriorly against the lateral posterior aspect of the posterior arch of the atlas on the side of lesion. The velocity should be high; the amplitude of motion short. Occipital counterforce, opposing adjustive force, is obtained by stabilization of the occiput manually.

Technique 1. Patient supine. Operator stands at the head of the table---extends the occiput and cervical column, side-bends the occiput and upper cervical area approximately four or five degrees to the side of lesion and rotates them toward the opposite side. The lateral aspect of the index finger of the left hand is the instrumentality of force and is placed firmly against the posterior arch of the atlas on the left side. The palmar aspect of the operator's right hand is placed along the right side of patient's head and face for

occipital counterforce. Sudden force is directed by the adjustive hand (left) in an anterior direction against the posterior arch of the atlas, while a simultaneous exaggeration of counterforce is obtained by exerting a little increase of stabilization pressure.

Technique 2. Patient sitting. Operator stands on the side opposite lesion, facing the patient. The flexed middle finger of the right hand is placed firmly against the posterior arch of the atlas on the left side. Extension, side-bending, to side of lesion, and rotation toward opposite side are completed, in the order named. The palmar aspect of the operator's left hand is placed against the lateral aspect of the patient's face and head for occipital counterforce. Adjustment is completed by strong quick snap of the middle finger in an anterior direction with increased counterforce at the moment of adjustment.

A point it is desired to emphasize in the use of the above varieties of technique is the absolute necessity of velocity. It is obvious that with the patient sitting, the superincumbent weight is greater, as the articulation is then bearing the weight-load of the head. With the patient supine, this factor is obviously mitigated and the operator is free of that particular obstacle.

Only one type of lesion has been considered from the point of view of adjustment---the unilateral anterior occiput on the left. If the lesion were a unilateral anterior on the right the operator would merely reverse the mechanical procedures. If the lesion were bilateral in character, adjustment would be given both sides by unilateral methods.

Compensatory Lesions of the Atlanto-Axial Articulation: In the anterior grouping, lesions of a torsion character, or, in other words, unilateral lesions are complicated by a definite act of compensation between the atlas and the axis. Assuming that a condyle is displaced anteriorly and to a slightly higher level, the condyles

which are normally constructed and situated to bear their respective share of the superincumbent weight can no longer share equally this burden, first because the superincumbent weight line must pass posteriorly instead of centrally through the long axis of the condyle in lesion and, secondly, because the anterior condyle is at a higher level. This means that the opposite condyle must bear the brunt of the burden and nature, to compensate for this inequality, causes the atlas to rotate posteriorly on the side of lesion, so as to bring the weight-lines to more nearly equal points through the respective condyles. In the posterior grouping of lesions of a unilateral character, the arc of rotation of the atlas is in the opposite direction, having the same object in view.

This is an added factor as to why the posterior arch of the atlas is relatively so much more prominent and would seemingly be indicated by its changed relationship with the occiput in the anterior grouping of lesions. The presence of this compensatory lesion is easy to detect, inasmuch as in any posterior rotation of the atlas on the side of lesion, the posterior arch will not only be more prominent posteriorly, but will crowd the median line and in the case of an anterior rotation on the lesion side (posterior grouping of the lesions) it will not only be relatively more anterior but more laterally disposed.

When using the "column of blocks" technique both for the unilateral anterior and posterior groupings, the same corrective forces which adjust the occipito-atlantal subluxation will adjust the atlanto-axial compensatory lesion. Inasmuch as the mechanics and adjustment forces are applicable to both. This however, does not apply when using occipital leverage and an absolutely distinct procedure must be used for adjustment of the compensatory lesion.

The Posterior Grouping: By this term is meant those lesions in which one or the other condyle, or both condyles are fixed in a relatively posterior position on the superior articular facets of the atlas below.

In this grouping, are included both the unilateral posterior occiput on the right and left and the bilaterally posterior occiput.

Bilaterally Posterior Occiput: This is a flexion movement on a transverse axis, wherein the condyles of the occiput move bilaterally backward, downward and slightly inward on the articular facets of the atlas below, with consequent immobilization in this position. The anterior extremities are at a lower and the posterior at a higher level than normal.

Etiology: Functional disturbance of this joint in flexion occurs more often than in any of its other classified movements. This is, however, so completely offset by the powerful extensor grouping of muscles that this type of lesion occurs much more rarely than has been stated in previous texts. Occupational or functional disturbances in which the head is constantly flexed, as for example, students, jewelers, office workers, etc., may be causative. Habitual faulty posture is a compelling factor. Atonicity of the extensors or hypotonicity of the flexors, particularly the former, may also be responsible. The special senses of the face protect the individual to a considerable extent from lesions of traumatic origin. This lesion occurs occasionally as a compensatory lesion, usually as compensatory for an exaggeration in the cervical curve---however if a hypotonic state of the extensor grouping exists, there is usually straightening of the curve, as is also the case when the occipital lesion is primary.

Diagnosis: With patient standing, the head assumes the position of flexion and is slightly more apparent than with the patient sitting. Motion is restricted particularly in the direction of the extension; in other words, it is apparently greater because of the relative fixation of the condyles. Suboccipital contractures are not present as a

usual thing, unless the lesion be of traumatic origin. A hypotonic state of these muscles is usually noted as the lesion is more often of long duration both in point of occurence and chronicity. The posterior arches of the atlas are relatively anterior and not easy to palpate. The normal separation of the ramus of the mandible and the outer anterior portion of the transverse process is bilaterally decreased, while a corresponding bilateral increase or separation occurs between the outer posterior portion of the transverse process and the tip of the mastoid process. The tissues surrounding the tips of the transverse processes of the atlas are abnormally sensitive. Unless the lesion be of traumatic origin, suboccipital sensitiveness is not marked. In fact, because of its chronicity, it is rarely as sensitive as its opposite fellow, the bilaterally anterior occiput. Subjective symptoms vary—patients usually complain of the sense of strain at the base of the occiput, rather than of marked discomfort.

Treatment: Eliminate all etiological factors insofar as is possible. Reduce bony subluxations unilaterally---one side at a time, as it is the most efficient way.

The Unilaterally Posterior Occiput: The unilaterally posterior occiput is a torsion lesion conforming to the same mechanical misconduct as that of the unilaterally anterior occiput with the exception that the condyle of the lesioned side moves on an arc of motion backward, downward and slightly medialward instead of forward, upward, and slightly medialward. The opposite condyle acts as the fixed-point axis for the arc of motion of its fellow and the axis of this motion could well be represented by a line drawn nearly vertically through the long axis of the condyle and the center of the articular facet of the atlas.

Etiology: Unusual muscular tension, trauma, faulty posture, occupational factors, forceful unexpected flexion, principally on the side of the lesion, counter-

balancing to other conditions, functional or habitual anomalies, refraction errors, etc., all are etiological factors which may produce this lesion. Dynamic and adynamic lesioning forces seldom have the same parallel intensity, consequently the torsion lesion is the expected sequence.

Diagnosis: The fixed relationship of the same side of the posterior arch of the atlas to the occiput will be so changed that it will assume a relatively more anterior position. This, of course, will cause the opposite side to be relatively posterior in relationship to its fellow, but not with the occiput. Moreover, the side of gross lesion will give evidence of greater sensitiveness and unequalized muscular tensions. Superimposed to this is the fact that the normal separation between the angle of the jaw and the end of the transverse process is decreased on the side of gross lesion and the opposite holds true between the end of the transverse process and the tip of the mastoid process on the same side. Correlated, these findings give an accurate diagnosis of the lesion. No appreciable changes will manifest themselves on the side opposite that of gross lesion. The compensatory lesion of the atlanto-axial articulation must be kept in mind at all times and ruled out by the measures previously suggested. The position the patient's head assumes in relation to the existing structural condition is suggestive. Supine, the head slightly in relaxation assumes a fixed position and is tilted to the side opposite the lesion. Restricted motion is more evident on the side of lesion.

Principles of Adjustment for Lesions of the Posterior Grouping Using Occipital Leverage.

1. **Extension:** As lesions of the posterior groupings are of the flexion type, either unilateral or bilateral in character, extension is the antithesis in joint movement. It should therefore be used if possible, not only for that reason, but moreover because it places the condyle at the best mechanical ad-

vantage to glide up the inclined plane of the superior articular facet of the atlas. Extension is almost absolutely necessary due to the nature and inclination of the joint surfaces as bony contact of joint planes would be the result of attempting this adjustment in any other position than extension. This would, perforce, limit complete adjustment.

2. Side Bending: With side bending are carried out two principles. It gaps the articulation it is necessary to move; and, secondly, approximates the articulation it is desired to have act as a fixed point axis for rotation, through the laws of compression and friction.

3. Fixation of the Arch of the Atlas: Oppose the direction of the corrective force of rotation by fixation of the arch of the atlas on the side toward which rotation is necessary. In lesions of the posterior grouping the fixation of the arch of the atlas will be on the side opposite to that in gross lesion; whereas, in lesions of the anterior grouping, it was on the side in gross lesion.

4. Rotation: Adjustment is completed with rotation. In lesions of the posterior grouping, rotation is conducted on an arc forward on the side of gross lesion and backward on the side opposite gross lesion; in other words, rotation is away from the side of lesion or toward the side opposite, whereas in lesions of the anterior grouping, rotation is toward the side in gross lesion.

Technique of Adjustment Using Occipital Leverage: For purposes of convenience and clarity of procedure consider the following hypothetical lesion---an occiput unilaterally posterior on the left. The principles of adjustment as carried out in order are as follows:

1. Easy extension.
2. Side-bending to the right.
3. Fixation of the arch of the atlas on the right.

4. Adjust with rotation of the occiput toward the right.

Technique 1. Patient supine. Operator stands at head of table, extends occiput and side-bends to the right to an angle of approximately 15 degrees from the midline of the body. He then places the index finger of his right hand, reinforced by the middle finger, against the posterior arch of the atlas on the right, while the right forearm rests against the antero-lateral aspect of the head. The operator thereupon places the palmar aspect of his left hand against the angle and the ramus of the jaw on the left side keeping firm pressure against the postero-lateral aspect of the arch of the atlas with the index finger reinforcement. He then rotates the occiput toward the right by coordinating the parallel forces of the right forearm and left hand. He does not disturb extension and side-bending when completing adjustment.

Technique 2. Patient sitting. The mechanical principles are the same as were used with the patient supine. The operator stands to the side opposite that of the lesion and leans against the patient so as to throw him off balance toward the side of lesion. He cups the patient's chin in the apex of his flexed right arm with the fingers of the same hand resting firmly upon the vertex of the head. The fleshy portion of the operator's left thumb is placed firmly against the posterior arch of the atlas on the right side. Maintaining a firm fixation of the atlas, a rotary force toward the right is brought to bear upon the lesioned articulation by the leverage action of the operator's right arm.

The following technique is used occasionally by the author. It is very effective.

Technique 3. Patient supine with head and cervical column over the end of the table. Correct right side first. Operator places right hand under patient's occiput, left hand under chin, and abdomen against vertex of patient's head. The cervical column should be flexed to its limit of motion, and the head, in full extension, lifted so that the weight of the body

is pulling downward on the atlas. Carry the head to the right side. This gaps the articulation (do not side-bend the head, then, keeping the patient in the same position, shift hands and repeat on the opposite side.

3. Strong upward pull against the chin with the left hand; but hold firm and stationary so as to allow gapping to take place). To make adjustment three things should be carried out synchronously:

1. Downward and forward pressure of abdomen against vertex of patient's head to increase extension.
2. Forceful upward thrust against base of the occiput with the right hand.

Adjustment of a bilateral condition can be easily affected by unilateral methods given above---the only difference being that they are applied to both sides in succession.

Occipitial Adjustment Via the Atlas: ("Column of Blocks" Technique.) The same mechanical principles used with occipital leverage technique can be used in this maneuver, although the lesion is regarded from a slightly variant viewpoint, and attacked from a different angle. The axis of motion passes vertically through the condyle on the side opposite the lesion. Two lever handles are apparent; a long and a short. The long lever handle is approximately twice the length of the short one. In this particular case the short lever handle is our objective and we carry out the same preliminary mechanical procedures of extension and side-bending. The side-bending is away from the side of lesion, so the articulation it is desired to use acts as the fixed-point axis. Our corrective forces are directed against the short lever handle. Before attempting adjustment, it is necessary to carry out the following movements:

1. Extension: This physiological movement locks the lower cervical and places the condyle in lesion in the best me-

chanical position possible to glide up the incline plane.

2. **Side-bending Rotation:** A slight degree of side-bending away from the side of lesion, followed by rotation toward the side of the gross lesion (side-bending to the right, rotation to the left), gaps the articulation the operator wishes to move, approximates and stabilizes the articulation he wishes to have act as a fixed point axis and the rotation gives a stabilization locking to the upper cervical.

3. **Adjust** by directing force anteriorly toward the lateral posterior aspect of the posterior arch of the atlas on the side opposite that of gross lesion. The velocity should be high, the amplitude of motion short. The occipital counter-force opposing adjusting force is obtained by stabilization of the occiput by pressure of the hands of the operator.

Technique 1. Patient supine. The operator stands at the head of the table, extends the occiput and cervical column, side-bends the occiput and upper cervical area approximately 4 or 5 degrees to the side opposite that of the lesion, and at completion of this, rotates toward the opposite side to a point of stabilization locking. The lateral aspect of the index finger of the right hand is placed firmly against the postero-lateral aspect of the arch of the atlas on the right side. The palmar aspect of the operator's left hand is placed along the left side of the patient's head and face, for occipital counter-force. Sudden force is directed by the adjusting hand (right) in an anterior direction against the posterior arch of the atlas, while a simultaneous exaggeration of counter-force is obtained by exerting a little increase of stabilization counter-pressure with the left hand.

Technique 2. Patient sitting. Operator stands on the side opposite lesion, facing the patient. The flexed middle finger of the left hand is placed firmly against the postero-lateral aspect of the posterior arch of the atlas on the right side. Extension, side-bending away from the side of lesion, and slight rotation toward the side of lesion are respectively

completed. The palmar aspect of the operator's right hand is placed against the lateral aspect of the patient's face and head for occipital counter-force. Adjustment is completed by a strong, quick snap of the middle finger against the posterior arch of the atlas with increased stabilization counter-force at the moment of adjustment with the right hand.

There is no objection to the use of the above technique. The mechanics are nearly perfect. There is, however, only one drawback, and that is that by working with a short lever handle more force is demanded. This, however, is very happily counteracted by the type of force used. It is cumulative force—velocity. It has two advantages: one, the fact that the mechanical principles are correct; and secondly, that the method is easy of accomplishment. Moreover, this same corrective force for the occipital lesion reduces the atlanto-axial lesion at the same time.

Only one type of lesion has been considered from the standpoint of adjustment---the unilateral posterior occiput on the left. If the lesion were a unilateral posterior on the right, the operator would merely reverse his mechanical procedure, as before stated. If the lesion were bilateral in character, adjustment should be given for both sides.

The Lateral Occiput: The lateral occiput is a lesion wherein the joint is fixed in a position of side-bending or lateral flexion. The condyle of one side moves medialward and downward, while that of the opposite side moves outward and upward. There is lateral tilting to the side which has moved medialward and downward, consequently a larger share of the superincumbent weight of the occiput is borne by the condyle of that side.

Etiology: Unequal muscular tension, especially a contracture of any of the following muscles, rectus capitis lateralis, semispinalis, splenius capitis, or

sternocleidomastoid, may be causative. The condition also may be produced by trauma, occupation, postural defects, etc. It may be secondary to rotation lesions in the neck.

Diagnosis: If side-bending is to the right, the condyles of the occiput will appear displaced to the left, and there will be a compensatory swerve in the cervical area. The transverse process on the right will appear to be nearer the occiput and mastoid process--in other words, higher in the apex of the angle formed by the two, and will also be more prominent laterally. The mastoid process of the same side and the angle of the jaw are less prominent, and tend to point more medialward, due to the inclination of the head. The direct antithesis holds true on the left. A very reliable probable sign of this lesion from the standpoint of inspection, is as follows:

The patient supine, and the head thoroughly relaxed, the midline of the face will tend to bisect at an angle the midline of the body. In other words the midline of the trunk, continued upward, seems to bisect the midline of the forehead, nose and chin, in such a manner that a large portion of the forehead falls on one side of the line, (right) and a greater portion of the chin on the opposite side of the line (left).

Tenderness is greatest over the transverse process which is most prominent. Restricted motion is apparently greatest in the direction opposite to that of the fixation (side-bending to the left). Subjective symptoms vary.

Principles of Adjustment by Occipital Leverage: The first principle is to obtain a stabilization locking of the cervical column. This may be done in the following manner: (1) by the use of forced flexion which locks the cervical from above downward, the degree determining the amount and the point downward to which this locking will carry. The author sometimes utilizes extension, which locks from below upward but does

Position for adjustment via the atlas of unilaterally posterior occiput on the left. Extension side-bending to the right and rotation to the left determines physiological locking of the upper cervical and a pivotal point for rotation through long axis of the neck of the right condyle. Stabilization resistance of the occiput is maintained while rotary adjustive force is applied against the short lever handle (arrow C) allowing long lever handle (arrow A) to rotate backward carrying facet backward under condyle. Arrow B indicates direction in which chin must point while adjustment is being made.

not include the atlanto-axial articulation, which he locks by side-bending rotation. In both instances he uses a stabilization locking sufficient to protect the cervical column from strain or injury, and moreover to give the maximum advantage of his adjustive and leverage forces.

The next fundamental principle is that of side-bending. This side-bending must be opposite to that in which fixation occurred. This is the physiological antithesis of lesion movement.

Technique 1. As the hypothetical lesion throughout, a lateral occiput to the right is considered. A fixation established in side-bending to the left.

Patient supine. Easy extension of the cervical column is the first step and locks all but the extreme upper cervical which are in turn locked by side-bending rotation (largely rotation) toward the left. The operator hooks the fingers of his left hand under the mastoid process of the patient. The combined thumb and flexed index finger (instrumentality of force) are applied to the angle of the jaw and the mastoid process, respectively. Reference is had to the right hand of the operator and the right side of the patient. With the cervical column locked together with a moderate degree of side-bending of the occiput to the right, simultaneous traction with the operator's left hand and transverse force with the right hand completes the adjustment.

Technique 2. Patient supine. Operator locks the upper and mid-cervical areas by forced flexion of the cervical column. The occiput is maintained in a position of side-bending to the left. The operator applies vertex pressure with the abdomen in such a manner as to cause the resultant force to pass obliquely through the condyle on the right side. This tends to force this condyle downward into the facet and inversely tends to force the opposite condyle up and out of its facet. Super-imposed to this he applies adjustive force with the combined thumb and index finger of right hand against

the angle of the jaw, and the mastoid process, respectively, on the right in a transverse direction and opposes this with counter adjustive force with the left hand against the lateral aspect of the vertex. This force is transverse in character also.

It must be kept in mind that relaxation of the lateral cervical musculature, although not absolutely necessary, is often indicated for the best possible results. The preparatory movements which lock the cervical column below the point of lesion have no particular effect upon the occipito-atlantal articulation, other than if forced they may to some extent limit motion by forced tension of soft tissues. The aim of all adjustive technique is to stabilize, protect and lock the column adjacent to the vertebrae in lesion, but to leave the joint involved absolutely unprotected, that the full capacity of leverage and adjustive force may in no wise be limited.

Technique 3. Patient supine with head and cervical column over the end of the table. Operator stands at the head of the table and grasps the head as follows:

(a) Right hand against right side of head and face.
(b) Abdomen against vertex of patient's head.
(c) Left hand against left side of head with fingers firmly against posterior arch of atlas.

Operator side-bends cervical spine to the right and head to the left. Three things are to be carried out synchronously:

(a) Increase side-bending of head with pressure of abdomen.
(b) With right hand operator should make a strong thrust with a little rotary twist to the right.
(c) Finger of the left hand should hold the arch of the atlas firmly, while palm of hand exerts lifting pressure against side of head. This movement serves to dislodge anterior extremities of the condyle (usually posterior); and if they do not, maintaining patient's head in same position, shift left hand,

so that fingers are under the angle of the jaw (palm in same position.)

Use the following method to finish reduction of the posterior extremities of condyles:

(a) Increase side-bending by pressure of the abdomen.
(b) Strong pressure against the base of the occiput with the right hand.
(c) Lifting pressure with the left hand; now with rocking motion and strong outward rotary movement, directed to bring greatest tension and separation to left latero-posterior position of the articulation correction is completed.

It is easier whenever possible to correct unilaterally. The operator may localize his efforts more specifically and efficiently by doing so. The same applies to moving any object. It is easier to move things by prying at the edges. The above technique, like the farmer moving the large rock, aims to follow out that principle.

Pseudo-Rotation Lesion of the Occiput: The pseudo-rotation lesion is a torsion lesion made up of a complexity of movements taking place at various intervals of time and having such peculiar physical aspects as to make it appear rotary in character. It is not a single combined movement, excepting when of traumatic origin, when external dynamic forces, rather than inherent mechanical possibilities, control the situation. External violence may act in such a manner as to cause both condyles to move at the same time in diverse directions around an imaginary central axis.

In the usual lesion, the unilaterally anterior, the occiput is the primary offender. The condyle in lesion describes an upward, forward and medialward arc of motion and the opposite condyle acts as the fixed-point axis. An indefinite period of time may elapse following which the condyle in

gross lesion may act as a fixed-point axis for an arc of motion of the opposite condyle downward, backward and medialward. Shifting arcs and axes of motion characterize this lesion. Because of the respective levels the condyles are obliged to assume an element of side-bending enters into the lesion. This side tilt is toward the side which is unilaterally posterior. This is not a true rotation lesion, having no central axis for rotation, hence the term pseudo-rotation.

Etiology: In any unilaterally anterior occiput there are certain mechanical forces which, if the lesion remains chronic for a long period of time, are apt to result in the pseudo-rotation lesion. Recall the fact that the condyle which acts as the fixed-point axis goes through a screwing motion---in other words, revolves upon its long axis. Visualize for a moment the direction of that revolution and you have the mechanical reason. Superimposed to that is the added factor that the inclination of the plane surface of the articular facet of the atlas is backward. Opposing this is the counter-force of extension which, although greatest on the side of gross lesion, must exert a secondary though minor effect upon the opposite condyle.

If it were not for the fact that the atlanto-axial articulation takes up a large percentage of traumatic rotary forces, the role of trauma in the production of this lesion would be a particularly heavy one. As it is, however, it exerts a minor influence only.

Diagnosis: The diagnosis is not difficult. The fixed relationship of the posterior arches of the atlas to the occiput and to each other will show greater disparity than in any other type of torsion lesion of the occiput. One is not only relatively anterior, but the other is correspondingly relatively posterior. Immobilization is greater than it is in the torsion lesion, both condyles being fixed; whereas in the unilateral lesion only the condyle in gross le-

sion is firmly fixed. The changed relationship between the mastoid process, the tip of the transverse process, and the angle of the jaw on one side is exactly opposite in character to that on the other. Sensitiveness will be approximately the same on both sides. By the simple act of rotation the atlanto-axial articulation fulfills the compensatory demands of the unilaterally anterior occiput on one side or the unilaterally posterior on the other.

With the patient supine and the head thoroughly relaxed, the midline of the face will be parallel but lateral to the midline of the body. In other words, the midline of the trunk continued upward would pass parallel, but lateral to the midline of the forehead, nose and chin. This same finding is characteristic to lesions of the atlanto-axial articulation, but with this main difference, that rotation around an imaginary central axis or in other words on a horizontal plane will show marked limitation of rotation in the direction opposite to that of the fixation if it is an atlanto-axial lesion. This movement does not affect the pseudo-rotation lesion of the occiput. Of course, the compensatory lesion of the atlanto-axial articulation must be ruled out. This can best be done by adjusting it previous to making the test.

Principles of Adjustment Using Occipital Leverage:

Extension: Since this lesion partakes of the characteristics of both a unilaterally anterior and a unilaterally posterior occiput it is impossible to use both flexion and extension at the same time. It is therefore necessary to utilize the one which is of greatest value. It is possible to get along without flexion, as it is easier for the anterior condyle to slip down the inclined plane than it is for the posterior condyle to slide up the inclined plane, particularly as the parallel inclination of these planes is so arranged as to render it almost impossible because of contact limitation. Therefore easy extension is used.

No side-bending: Inasmuch as both condyles are in le-

sion in opposite directions and we do not wish to enforce any limitations of motion upon either one of these condyles in making adjustment, side-bending should be ruled out.

Fixation of the Arch of the Atlas: It is necessary to oppose the direction of the corrective force of rotation by fixation of the arch of the atlas on the side toward which it is desired to rotate.

Rotation: Adjustment is made with rotation together with slight traction around an imaginary central axis. This movement must be on as near an horizontal arc as is possible.

Technique: Any of the technical procedures given for the torsion lesions previously discussed is satisfactory, providing the above principles are fulfilled.

The Impacted Occiput: This, as the term signifies, is a fixation with the joints in their central range of motion. It is due to a hypertonic state of both the anterior and the posterior suboccipital groupings of musculature. There is marked restriction of motion, apparently no greater in one direction than in another. The whole suboccipital area appears sensitive to palpation and diffusely contractured. The patient may complain of a great deal of suboccipital discomfort ranging from vague neurotic pains to well-defined congestive headaches.

Treatment is traction. Alternate traction and release of traction. A technique which the author uses, and which is highly effective for this condition is Technique I, under treatment of the lateral occiput. The only difference in the application is that the combined thumb and index finger is used to secure a stabilization force rather than an adjustive force, and the object is to break fixation and gap the joint surfaces. This method is used bilaterally, gapping one articulation at a time.

CHAPTER V.

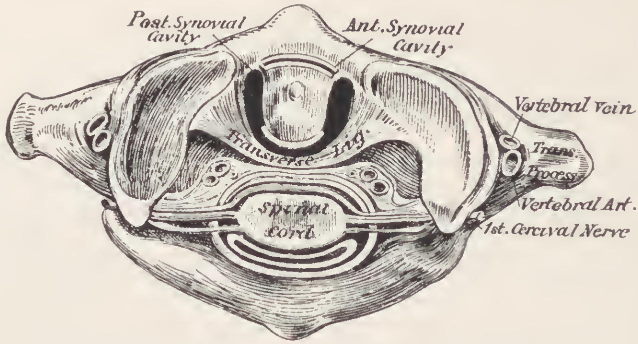
THE ATLANTO-AXIAL SUBLUXATIONS

The atlanto-axial joint has four distinct articulations, each covered by a synovial membrane. The atlas revolves on a nearly vertical axis around the odontoid process of the axis, forming a pivot joint with two articular surfaces, one between the odontoid process and the anterior arch of the atlas, and the other between the odontoid process and the transverse ligament. The lateral articular processes are arthrodial articulations. The articular surfaces are raised in the center and fall away at the edges, thus allowing, at first, some ligamentous slackening in rotation, thereby increasing the amount of this movement. The mobility of this joint for rotation is marked, the atlas and the skull moving en masse upon the axis. Movement beyond a certain limit, however, is prevented by the alar or check ligament. Primary movement is asymmetrical, the axis of movement being in the atlanto-axial articulation of the side to which the head is rotated. This soon changes and the movement becomes symmetrical around the odontoid process of the axis. The muscles producing this movement are the sternocleidomastoid and semispinalis capitis of one side acting with the longus capitis, splenius, longissimus capitis, rectus capitis posterior major and obliquis capitis superior and inferior of the opposite side. The second cervical nerve passes out behind the superior articular process of the axis.

Normal movement of the atlanto-axial articulation is largely confined to rotation, although a slight degree of flexion, extension, and side-bending is possible.

The Rotation Lesion: The common lesions of this joint are:

1. The unilaterally anterior atlas on the right, posterior on the left(rotation lesion to the left.)



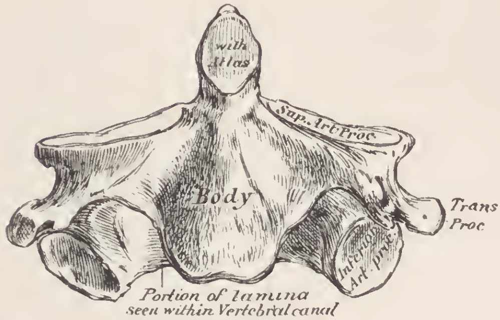
Articulation between odontoid process and atlas.

2. The unilaterally anterior atlas on the left, posterior on the right (rotation lesion to the right).

The nature of the joint is such that these lesions are many times nothing more than functional disturbances due to unequal muscular tension. They are frequently secondary, counterbalancing to other lesions. In fact, a rotation lesion of this articulation is more often compensatory than primary.

Etiology: The lesion when primary, is usually due to reciprocal innervation through the medium of the nerve reflex with resultant muscle spasm and imbalance of tensions. It may be due to unequal muscular tension or perverted equilibrium, as a result of a lesion of a neighboring vertebra. It is one of, if not the most common, counterbalancing or secondary lesions found in the cervical column. It is invariably present in the unilateral, pseudo-rotation, and side-bending lesions of the occiput, providing those lesions are of long standing. It is occasionally counterbalancing for upper thoracic vertebral lesions and sometimes for first or second rib subluxations through the scalemus muscles. Functional abuse may be a predisposing factor, as for instance in the case of a violinist in the act of playing. Trauma, providing it is of a torsion character, is an important factor.

Diagnosis: The point of greatest sensitiveness is in the sub-occipital area, over the posterior arch and transverse process of the atlas, which has rotated



The axis, anterior view.

posteriorly. The relative position of the posterior arches of the atlas are significant. The posterior arch which rotates posteriorly crowds the median line, while its fellow rotates anteriorly and is more laterally situated. Therefore one arch is postero-mesial and its fellow is antero-lateral. The position that the head of the patient assumes when in the supine position and completely relaxed is such that the midline of the trunk continued upward passes parallel to, but lateral to the midline of the forehead, nose and chin. Functionally, test the joint by rotating the head from side to side, being careful to eliminate all extraneous cervical movement by making this rotation with the head in the erect position (neither flexion nor extension) and on a horizontal plane. There will be limited rotation toward the side opposite that of fixation; that is to say, rotation is limited toward the anterior side.

Principles of Adjustment:

1. **Easy extension:** Easy extension locks the cervical column from below upward, the degree of extension determining the extent and the point to which this will carry. This extension should not be forced. The atlanto-axial articulation is not influenced; in fact, practically all movement of side-bending rotation is confined to the very upper cervical. As the lesion is a rotation lesion, we have enforced no limitation upon the joint in lesion and consequently no limitation in adjustment possibilities. It is left unprotected for adjustment.

2. **Side-bending:** This side-bending must be toward the side unilaterally posterior. This is the first fundamental law in physiological or articular locking as it fulfills the necessity for approximation of facets. Physiological locking is impossible to obtain unless the facet surfaces are in close apposition, inasmuch as it is an articular locking and not forced tension of soft tissues. Without close apposition of the facet surfaces motion is then limited only by the forced tensions developed in the soft tissues in and around the joints and adjacent muscular structures. This movement, moreover, gaps the opposite side, allowing plenty of room for that particular joint to retrace its lesion pathway without application of adjustive force. This side-bending depends upon the situation in the cervical column and the obliquity of the plane surface. In this particular instance, the degree of side-bending is approximately 12 degrees from the midline of the body.

3. **Rotation:** By means of rotation toward the side unilaterally anterior, we complete our physiological locking of the upper cervical. We cannot lock the vertebrae in lesion because of its lesion position but we have physiologically locked the spine in the area in the direction and in the plane in which we are going to apply corrective force, this corrective force being directed against the posterior arch which is unilaterally posterior.

4. **Adjustment:** The adjustive hand delivers adjustive force in an anterior direction against the point of greatest leverage, the arch of the atlas which is unilaterally posterior. Physiological locking has been completed in the direction and plane and on the side on which this adjustive force is to be given.

The opposite hand accomplishes three things:

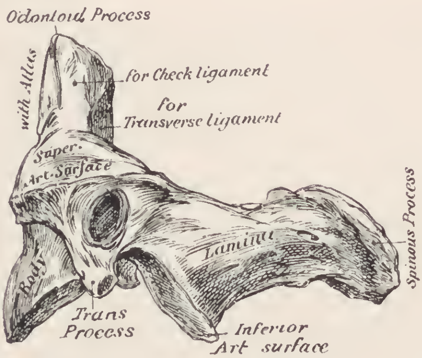
1. It supports and protects the very upper cervical column, acting somewhat as a splint.

2. It aids and largely controls the act of physiological locking (side-bending and rotation).

3. Further exercise of the forces of physiological locking after the locking has been completed constitutes leverage force. This transition is automatic and instantaneous.

Technique of Adjustment: We will consider as the hypothetical lesion a rotation lesion of the atlas to the right in which the atlas is unilaterally anterior on the left and posterior on the right. The mechanics of adjustment are as follows:

1. Easy extension.
2. Side-bending to the side unilaterally posterior, angle approximately 12 degrees.
3. Rotation toward the side anterior.
4. Adjust with simultaneous utilization of adjustive and leverage-force.



Lateral view of the Axis.

Technique 1: Patient supine. (Direct-action technique). The objective is the transverse process which has rotated posteriorly. The instrumentality of force is the lateral aspect of the index finger of the right hand (adjustive hand). The head and cervical column is carried into easy extension side-bending to the side unilaterally posterior and rotation toward the side unilaterally anterior (left). The left hand is placed along the lateral aspect of the suboccipital area of

the left side. Rotary adjustive force is delivered against the posterior arch of the atlas (right side) and the left hand co-ordinates with it in such a way as to deliver counter-force and leverage-force.

Technique 2: (Direct-action technique). Patient sitting. The operator stands facing the patient and to the side opposite the transverse process posterior. The palmar aspect of the slightly flexed middle finger is placed firmly against the posterior arch of the atlas which is unilaterally posterior, and the patient rests the head on the hypothenar eminence of the same hand (left hand). The right hand of operator is placed along the left lateral aspect of the patient's face and head. This is counter and leverage-force. The left hand delivers the adjustive force. The physiological movements of extension; side-bending to the side posterior and rotation toward the side anterior, must be completed before adjustment is attempted.

A point which must be emphasized in the use of side-bending and rotation is that these forces must be focalized to the point of lesion. The apex of the angle formed by the midline of the body in relation to the side-bending of the head and upper cervical column must be at the point of lesion. The rotation must be focused in such a manner as to bring the greatest possible rotary strain at the point of lesion. This principle is true for any articulation in which physiological locking of side-bending rotation is used.

Adjustment by Indirect-Action Technique: Indirect methods are not as easily controlled as are direct methods. Ease of accomplishment of adjustment is greater in direct-action technique. The following technique is of value, however, and is not particularly difficult to apply.

Indirect-action technique: Patient supine. Fixation with fingers of one hand on vertebrae below (axis), especially the

transverse process upon the same side that vertebra in lesion (atlas) has rotated forward. With other hand against side of face and head, retrace the pathway of lesion movement by rotating occiput and atlas en masse toward anterior side. The patient's head should be held in a position of side-bending toward the side which is unilaterally posterior. This movement causes a separation on the side which is unilaterally anterior thereby allowing plenty of room for a backward movement on that side. With slight variations same technic may be used with patient in sitting posture.

Other possible lesions of the atlas are:

1. Lateral atlas to the right.
2. Lateral atlas to the left.
3. Extension lesion of the atlas.
4. Flexion lesion of the atlas.

The Lateral Atlas: Due to the inclination of the articular facets of the axis, slight lateral gliding may take place with rotation in the atlanto-axial joint. This is a sort of skidding movement of the atlas as it rotates around the odontoid process so that the side which moves anteriorly tends to slip laterally and slightly downward, while the opposite side tends to slip medially and slightly upward, crowding odontoid process on that side. Illustrative of this movement of the facet forward is the familiar sight of the skidding of an automobile on a curved, crowned road. The result of this movement is that the side which rotates forward is more lateral and at a lower level than normal; while the other is at a higher level and more central. The atlas, therefore is laterally displaced on the side which rotates anteriorly. For example: a lateral atlas to the right is the result of a rotation to the left in which the atlas has moved forward, slightly outward, and downward on the right. These lesions are usually compensatory for torsion lesions of the occiput, and also the lateral occiput, (lateral occiput to the right, lateral atlas to the right).

Diagnosis: Marked lateral projection of the end of the transverse process of the atlas on the side which has rotated anteriorly, together with the assumption of a slightly lower level are characteristic to the anterior side. Less prominence of the end of the transverse process with the assumption of a slightly higher level are characteristic of the posterior transverse process. These particular features superimposed upon the diagnostic tendencies and physical findings of the rotation lesion will give a correct analysis of the lesion, inasmuch as side-bending is not an independent movement, but merely a portion of a composite tendency of rotation side-bending. Under certain conditions, a proportionately greater amount of side-bending may take place.

Treatment: Adjust as a rotation lesion, using the same technique with only slight variation. If direct-action technique is used, emphasis should be laid upon preliminary rotation (less side-bending and approximation).

The extension lesion is nothing more than a functional or counterbalancing movement in which there is separation in front with slight upward gliding of atlantal articular surface upon the anterior articular surface of the odontoid and approximation posteriorly with slight compression of the articular disc.

The flexion lesion is a functional disturbance with movement the reverse of that of the extension lesion.

Treatment: Both lesions should be directed to the etiological factors and not to the conditions themselves.

The atlas cannot be bilaterally displaced anteriorly or posteriorly on account of the odontoid process of the axis, the anterior arch of the atlas, and the transverse ligament without fracture of the odontoid process or anterior arch of

the atlas, or rupture of the transverse ligament. This knowledge is taken advantage of in execution by hanging, in which the transverse ligament is ruptured and odontoid process driven into substance of spinal cord.

Fracture of the atlas is rare but several cases are on record where it has taken place as the result of extreme trauma. Its effect on the higher vital centers of the medulla is great.

A valuable sign of meningeal irritation is Brudzinski's neck sign: an involuntary flexing of the legs on the thighs, and of the thighs on the pelvis when the head is passively forced toward the sternum (forced flexion). It is pathognomonic of irritation of the meninges. The Binda shoulder sign of tuberculous meningitis is a sudden movement of the shoulder, when the head is passively turned toward the other side. It appears contemporaneously with Brudzinski's sign.

CHAPTER VI.

SUBLUXATIONS OF THE CERVICAL VERTEBRAE FROM THE SECOND TO THE SEVENTH INCLUSIVE

A typical cervical vertebra will be reviewed here only with reference to those factors which are important to osteopathic mechanics and to which later allusion will be made.

The body of the vertebra is small and broader laterally than antero-posteriorly; its anterior surface is at a slightly lower level than its posterior. Superiorly the body presents a prominent lipping of its posterior and lateral borders, while the inferior surface has a projecting lip on its anterior border which helps to prevent a slipping backward of the vertebra. This latter feature is a protective provision of nature and stabilizes the cervical curve, which is convex anteriorly. The lateral lipping is a protection against lateral displacements.

The superior and inferior processes on either side are situated at the junction of the pedicles and laminae, which form, by their fusion, lateral columns of bone. The articular facets are nearly flat and oval in outline. The superior members face upward, backward, and slightly lateralward and the inferior downward, forward, and slightly inward.

The third cervical vertebra is the smallest of the series. It occupies the apex of the cervical curve. The above facts together with its relative position in the cervical spine make it particularly responsive to lesioning forces.

The transverse process of the cervical vertebrae present, near their bases, foraminae for transmission of the vertebral arteries, veins, and plexuses of sympathetic nerves. The extremity of each process is bifid with each arm terminating in a tubercle referred to as the anterior or posterior tubercle.

Considerable care should be taken in palpating around the anterior or costal tubercle of the transverse process of

the sixth cervical vertebra as the carotid artery is compressed against it. This tubercle is known as Chassaignac's tubercle or the tuberculum caroticum.

Normal motion between the second and third cervical vertebrae is less free than elsewhere in the cervical spine. This is particularly true of flexion and is due to the thinness of the intervertebral fibro-cartilage.

Anterior view of cervical vertebra.

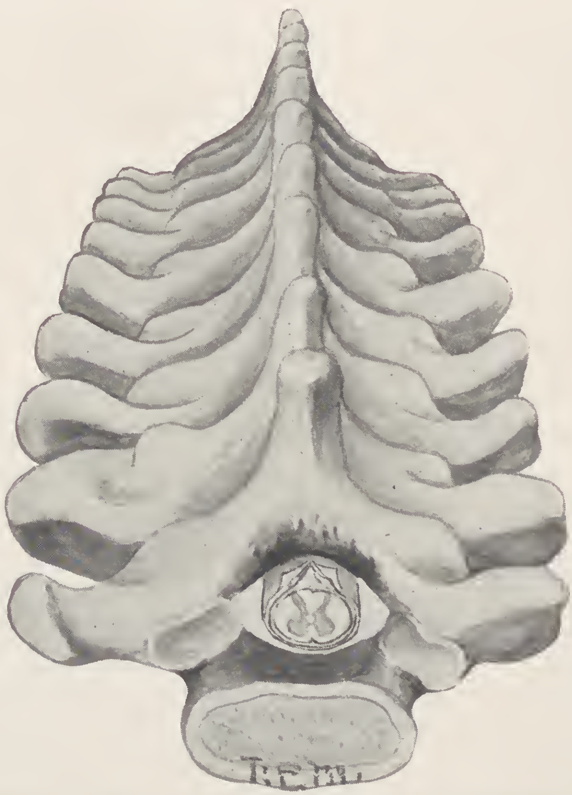
The pulpy nucleus or central portion of the intervertebral fibro-cartilage is situated somewhat behind the center of the disc and forms a mass of very elastic and tightly compressed material which constitutes a central elastic pivot or ball upon which the middle of the vertebra rests and upon which its body can twist, tilt, or incline. It is separated from immediate contact with the bone by a thin plate of cartilage. Embryologically it is a persistent vestige of the fetal notochord.

The articular processes steadily influence and limit the movements of the spinal column, assist in bearing the superincumbent weight of the body, and endow the spine with a capacity for movement by muscular agency.

The normal movements of the cervical spine are flexion, extension, and rotation side-bending or lateral flexion.

Rotation and side-bending are inseparable because of the position and inclination of the articulating facets, causing movement to take place upon an oblique axis. However, from above downward the obliquity of the articular facets increases, thereby relatively increasing the proportion of

side-bending in the lower cervical spine. Due to this fact Ashmore calls lesions of the upper cervical area rotation-side-bending and those of the lower cervical area side-bending-rotation. No inference should be drawn from this as to the direction of the rotation of the bodies of the vertebrae as in both cases it is to the concavity of the curve. Flexion and extension influence rotation and side-bending in that the total amount of movement is increased with the spine in easy flexion and slightly limited in easy extension. Forced extension limits it markedly and forced flexion limits it slightly. The ratio of rotation has a tendency to be increased with the spine in extension, and the ratio of side-bending is increased with the spine in flexion, although as previously stated, extension and hyper-flexion limit the total amount of movement.



Section of the cervical column looking downward, indicating planes of articulations and general morphology.

In rotation-side-bending and side-bending-rotation the ratio of anterior articular movement upward and forward on one side is approximately three or four times greater than downward, backward articular movement of the opposite side, as the latter can move only slightly (approximately one-sixteenth of an inch) before it reaches its limit. The lower anterior lip catches over the body of the vertebra below, the lower anterior portion of the inferior articular facet catches at the base of the superior articular facet or the lamina of that vertebra and the transverse process hooks over its superior articular process. The above bony contact limitations of this side are such as to prevent further movement and the axis for rotation shifts from the nucleus pulposus and becomes an oblique axis passing through the articular process and facet of this side, thereby allowing of further movement upward and forward on the anterior or opposite side. Movement changes from the symmetrical to an asymmetrical type due to the shift from a central to a unilateral fixed-point axis.

Fryette claims that when any area is in easy physiological flexion and side-bent, the bodies move toward the convexity and if any area is in hyperflexion, or to a lesser extent extended and side-bent, the bodies rotate toward the concavity. Moreover, that this is due to the fact that in slight or easy flexion, articular facets are not in contact or locked and the load is thrown more upon the bodies of the vertebra, so that the superimposed weight becomes an important factor, and when spine is side-bent, the bodies have a tendency to crawl out from under the load by rotating toward the convexity.

Side-bending-rotation with body rotated to the convexity is applicable alone to the mid-dorsal spine in a position of hyperflexion: in fact, the author believes it to be found there only under the above circumstances.

Rotation of the body of a vertebra toward the convexity of the curve outside of organic curvature and the above

functional inclination which has been mentioned is considered impossible. If such rotation does occur the physical reasons for the phenomenon are still unproven and have not been substantiated by scientific investigation. Providing that, as in the case mentioned by Fryette, side-bending is the primary movement, an apposition of the articular facets soon occurs and from that point movement becomes side-bending-rotation and the body must then rotate toward the concavity of the curve for the plane of movement is thereafter controlled or directed by the articular facets and associated dynamic muscular influence. The preceding factors are of considerable value in the study of functional curvatures.

A more succinct statement of the facts is as follows: When any given area is in easy flexion and side-bent, the proportion of rotation of the body of a vertebra toward the concavity is considerably lessened over that occurring in the erect position and, with any given area in hyperflexion or extension, in side-bending the rotation of the bodies of the vertebrae toward the concavity is increased over that possible in the erect position. Moreover, in the former, side-bending is the primary movement and in the latter rotation is the primary movement.

Flexion of the Cervical Vertebra: This movement occurs upon a transverse axis through the center of that portion of the body of each vertebra which is in contact with the nucleus pulposus of the intervertebral disc below. This pulpy nucleus of the intervertebral fibro-cartilage is, throughout the entire movement of flexion, the pivot or ball-bearing over which movement must take place.

The inferior articular facets of the vertebra above move upward and forward on the superior facets of the vertebra below and become bilaterally anterior in their relation to the latter.

The posterior ligaments are tensed, due to the separation of their attachments and the relative length of the column is increased posteriorly thereby obliterating to a more or less extent the normal cervical curve. The amount of this obliteration is dependent upon the amount of flexion. This same rule holds true to the relative increase in the length of the cervical spinal column posteriorly.

Anteriorly, all changes are approximal in character. The relative length of the spine anteriorly is diminished, the convexity of the cervical curve anteriorly is lessened, the anterior portion of the inter-vertebral disc is subject to compression and the adjacent ligaments slackened.

When the entire spinal column is moderately flexed the upper cervical and lumbar regions become locked, this being a forced tissue tension locking of an anatomical character. In extreme flexion the whole spine is locked although the lower cervical and thoracic column can not be as completely locked in flexion, even though that flexion be severe, as is possible in the physiologic movement of extension in which the first areas to lock are the lower cervical and dorsal parts of the column. If such lockings are primarily attempted the possibility of subsequent rotation or side-bending in the locked areas is prohibited.

In the cervical column flexion locks from above downward and extension locks from below upward and these two opposing movements nullify each other at the third cervical, their opposition being complete at this point.

Extension of the Cervical Vertebra: The inferior articular facets of the vertebra above move bilaterally downward and backward upon the superior articular facets of the vertebra below. However, movement of the inferior articular facets downward and backward is short-lived, as transverse articular fixation almost immediately takes place. Primarily, movement occurs

upon the same axis as that of flexion, the nucleus pulposus acting as a pivot or ball-bearing. It is logical to assume, after relative comparison of the amount of flexion and tension in the cervical area together with their respective articular movements, that the axis for further movement of extension must shift from the nucleus pulposus and body of the vertebra to a transverse axis drawn transversely through the articular processes of the vertebra, thus allowing more pronounced separation anteriorly. Posteriorily, all changes are approximal in character. In brief, the reverse of flexion, with the relative length of the column increased posteriorly, ligaments relaxed and slackened and anterior convexity increased is encountered.

Forced extension locks the entire spine because the inferior articular facets of each vertebra are jammed down on the laminae of the vertebra below. Moderate extension locks all but the upper cervical column, the last one or two dorsal and the lumbar area. The upper dorsal is the first to lock in extension, and the last to lock in flexion. This is nature's way of protecting and reinforcing vertebrae in extreme positions. Knowledge of these particular anatomical lockings is important in consideration of their value when fixation or immobilization is desired for any corrective purpose.

Lesions of the Cervical Vertebrae: The common lesions of these articulations are: the rotation side-bending, or side-bending rotation lesion to the right, (syn. unilaterally anterior on the left, posterior on the right) and the rotation side-bending or side-bending rotation lesion to the left (syn. unilaterally anterior on the right, posterior on the left).

Other possible lesions are flexion and extension lesions (syn. bilaterally anterior or bilaterally posterior, respectively). These lesions are confined to the very lowermost cervical vertebrae, i. e., the fifth, sixth and seventh.

Tucker states that cervical vertebrae may be also unilaterally posterior on the right or left or unilaterally anterior and that this particular type of torsion lesion does not necessarily infer a corresponding displacement on the opposite side. Of these lesions, he further states, the unilateral posterior is the more common.

Such a type of lesion, however, necessitates asymetrical movement of a unilateral order, with the axis of movement passing obliquely vertical through the articular process and articular facets on the side opposite that of gross lesion. The mechanical difficulties of such a primary movement are such as to preclude any great frequency of this type of lesion. Under forced conditions, it may possibly occur, although rarely. The author has previously stated that rotation first takes place on a more or less oblique although nearly vertical axis, passing through the nucleus pulposus of the intervertebral disc and that this movement of rotation is symmetrical until bony contact limitation prevents further downward, backward movement on the side which rotates postero-inferiorly. This allows of a fixed-point axis, an axis passing obliquely, although approaching the vertical through the articular process and facets on the side to which the vertebra is rotated. Movement of rotation, further continued, must be asymetrical, revolving around this fixed-point axis and allowing of a much greater arc of motion of the articular facet which rotates upward and forward. Under such circumstances as Tucker mentions, however, there is nothing to maintain one articular process as a fixed-point axis of an arc of movement of the opposite facet. The mechanical difficulty of such a state is therefore entirely obvious.

Directly lateral lesions on the right or left are lesions mentioned by Tucker as being characterized by a lateral displacement maintained evidently by a catch of the lateral lip of the body of the vertebra against the tissues at the base of the opposing bone. Such a type of condition is rarely found

and only apt to occur in the lower cervical spine, if at all.

The mechanics of correction for such conditions should suggest themselves. In brief, adjustment consists of flexion and strong side-bending with a rocking motion to separate and dislodge the catch.

Etiology of Cervical Lesions: A cervical lesion, when primary, may be due to that particular nerve reflex phenomenon which we term reciprocal innervation. The resultant muscle-spasm and imbalance of tensions is sufficient to produce a subluxation, the character of which is responsive to and dependent upon the nature of the unequal muscular tensions. It may be due to some postural, occupational, or functional anomaly, in which case the stabilization of its adjustment is dependent upon the removal of the underlying primary factor. Trauma is another common cause and the subluxation is then the result of some wrench, twist, or direct violence. It is occasionally secondary to other spinal lesions for which it may be counterbalancing or compensatory so as to maintain the greatest possible efficiency of equilibrium. It may be the result of an extension of inflammation, and in nature a rhemuatic diathesis with a focal infection elsewhere.

Exposure of the neck to rapid thermal changes, drafts etc., may be a causative factor. Defective hearing and visual disorders may either reflexly or because of the particular position the patient has to assume because of his ailment, have a pronounced etiological bearing. It would be impossible to enumerate each and every cause of the cervical lesion.

The Rotation Side-bending, or Side-bending Rotation Lesion: A cervical vertebra, second to the seventh, inclusive, maintained unilaterally anterior on the right, posterior on the left, and vice versa, a vertebra immobilized unilaterally anterior on the left, posterior on the right, is a rotation side-bending or side-bending rotation lesion to the right and left, respectively.

Diagnosis: For the purposes of convenience, we will consider a hypothetical lesion, a third cervical vertebra immobilized unilaterally antero-superiorly on the left, postero-inferiorly on the right. The above lesion is a rotation side-bending to the right.

The deviation of the spinous process is to the left and the body of the vertebra rotates to the right and assumes a slightly tilted position so that the intervertebral disc is pinched on the right side. The transverse and articular processes on the left move upward and forward and become approximated with those of the vertebra above on the same side. The anterior or costal tubercle is more prominent anteriorly, very sensitive to palpation, and a diagnostic land-mark of value. The transverse and articular processes on the right assume a downward and backward position and are approximated to those of the vertebra below on the same side. The posterior tubercle of the transverse process and the articular process itself are more prominent posteriorly, very sensitive, and diagnostic land-marks of value also.

The main points on which to base a diagnosis are the relative comparison in position of the anterior and posterior tubercles of the transverse processes together with the changed positions assumed by the articular processes. Comparison should be made of one side with the other. There is usually marked tenderness over the spinous, articular and transverse processes. The articular process which is rotated posteriorly is particularly sensitive as is also the costal tubercle which has rotated anteriorly.

The position that the patient's head and cervical column assumes in relation to the underlying structural conditions is somewhat characteristic and a more or less probable sign of the nature of the condition. Lengthening of the cervical column occurs on the anterior side. The nature and location

of soft tissue changes and subjective symptoms will determine only the presence of a lesion, but give no definite information as to the nature and character of it.

The relative position of the spinous processes cannot be relied upon as an accurate diagnostic feature as they are so often subject to anatomic variations. They may help to substantiate other findings but should never be relied upon as giving a true estimate of the position of the vertebra in lesion. Too much emphasis is sometimes given to them as they are so obvious and freely palpable.

One of the most accurate means of diagnosis at our command is, by the utilization of physiological movement, to exaggerate the lesion. In the above hypothetical instance, fixation is in rotation side-bending to the right. Exaggeration of the lesion then consists in rotation side-bending to the left. In other words, in moving that area of the spine in which the lesion is situated, through the utilization of specific physiological movement in a direction which is the exact antithesis to that in which the lesion is immobilized. If on so doing, the vertebra apparently in lesion gives the appearance of being still more decidedly in lesion, there is added proof of the presence of fixation and of the nature and character of that fixation. If, on reversing the side-bending rotation, the vertebra in lesion apparently disappears, there is still more conclusive proof of its presence, as you have then ruled out the possibility of some anatomic variation being the cause of an apparent subluxation. In conclusion, it must be stated that if a vertebra shows anatomic findings which indicate a lesion of a certain type with the cervical column in a normally erect position, (neither flexion, extension, side-bending nor rotation) and if this same vertebra shows evidence of decided increase of anatomical variance when physiological movements are utilized, the direct opposite in direction of those in which the lesioned vertebra is immobilized, the presence of fixation and the nature thereof are thereby fully demonstrated.

The same combination of movements that produced the lesion carried to their full capacity in that area, would cause the lesion apparently to disappear, providing there is no anatomical malformation of the vertebra in lesion, and providing sion apparently to disappear, providing there is no anatomrange of activity, in which case the condition would be a dislocation rather than a subluxation.

This method of diagnosis by physiologic restriction of motion can be utilized for all areas and all types of spinal subluxations. It is probably the one best diagnostic maneuver at the operator's command as he can only draw inferences from objective physical findings as to the position of the vertebrae, while the physiologic findings give a true estimate of the underlying condition.

Principles of Adjustment:

1. **Flexion Extension or the Erect Position.** The first step in the production of a complete physiological locking of the area involved consists in the proper use of flexion extension, or the erect position. Its particular value is to bring the greatest amount of side-bending rotation in and about the vertebra in lesion, that the physiological locking may be as complete as possible, and thereby insure a full range of arthrodial movement to the vertebra in lesion in the direction opposed to that in which it has become fixed. The author has previously stated that flexion locks the cervical column from above downward and extension locks it from below upward; and that their opposition is complete at the third cervical. The correct inference to be drawn from this is that the greatest range of side-bending rotation movement is at the third cervical and possible only when the cervical column is in the erect position. In other words; in neither flexion nor extension. All adjustments of torsion lesions at this point should be made in the erect position. All adjustments of lesions above this point should be made with a gradual increase in extension, the higher in the column the lesion is, the greater

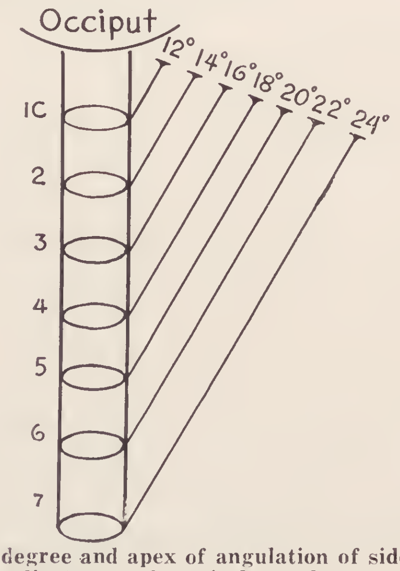
the degree of extension. All lesions below the third cervical should be adjusted in a gradual increase of flexion from above downward, the lower in the column the lesion, the greater the degree of flexion. Proper use of the above movements can be so accurate as to confine the greater proportion of movement to the articulation in lesion, which is the desired thing. It is obvious, then, that in a lower cervical lesion we have enforced no limitation upon the joint in lesion, so that it has a full possibility of complete arthrodial motion in the reverse direction to that of fixation but that with the same movement we have superimposed upon the area above the lesion an anatomical locking in flexion.

In a lesion of the upper cervical, extension is the prime movement as it effects an anatomical locking of the lower cervical and at the same time enforces no limitation upon the joint in lesion, but rather gives it the fullest possibility of complete arthrodial motion in the reverse direction to that of the fixation.

In both instances the lesion is left unprotected for adjustment.

2. **Side-bending:** This side-bending must be toward the side unilaterally postero-inferior as this is the first fundamental law in physiological or articular locking. Apposition of articular facets is necessary and this apposition must be upon the side on which adjustive force is to be given. It must be understood that articular or physiological locking, as it is called, is not a locking through forced tension of tissues, but rather a locking in which the inherent mechanics of the articular facets play a considerable part. This prime movement enforces a physical restriction upon the articular facets themselves by the added compression to which they are subjected. Superimposed upon this primary movement of side-bending is secondary rotation in the reverse direction to that of the side-bending which brings the articular facets on the side of lesion upward and forward to a point of complete limi-

tation where they articularly lock without possibility of strain or injury to the soft tissues in and around the joints and adjacent confining structures. Moreover, the movement of side-bending gaps the opposite side allowing plenty of room for the anterior articular facet to retrace its full arthrodial excursion. The degree of side-bending depends upon the situation in the cervical column and the obliquity of the plane surface. For lesions between the second and third cervical, the amount of this side-bending should approximate an angle of fourteen degrees with the midline. The apex of the angle of this side-bending should be at the point of lesion. In other words, the midline of the body and the line of side-bending of the cervical column above the point of lesion should constitute two sides of this angle and its apex should be at the point of lesion---the point of junction of these two lines. It is therefore obvious that the lower in the column the lesion, the wider the sweep of the occiput from the midline, if the same degree of angulation is to be effected at the point of lesion, as the line lengthens from above downward. Because of the increased obliquity of the plane-surfaces from above downward there is an increase in the degree of angulation of approximately one degree for each vertebra.



Diagramatic key showing degree and apex of angulation of side-bending necessary for adjustment of cervical vertebrae.

3. **Rotation:** Rotation must be toward the side unilaterally antero-superior. This procedure performs a dual function as it primarily completes physiological locking by carrying those vertebrae immediately above and below the lesion to a point of articular locking in the direction in which we are to apply our adjustive force. At the completion of this locking produced by dissemination of the forces of side-bending and rotation above and below the lesion, we still have force, bearing in at the point of lesion, although this force is no longer a locking mechanism but rather an effective natural leverage force. Rotation should be such that the rotary strain is greatest at the point of lesion and the direction of this rotary strain should be parallel to the planes of the articulations. The end result of this focalization of forces to the articulation in lesion produces a maximum amount of leverage force and at the same time gives a complete combination of physiological and anatomical locking of the cervical column at all points other than the articulation in lesion.

The muscular action of side-bending, reverse rotation is such that these two muscular agencies oppose each other. The action of one harmoniously and completely nullifies the action of the other in such a way as to add to the efficacy of a locking process with complete avoidance of muscular strain.

4. **Approximation:** This particular mechanical force may or may not be utilized. It is occasionally necessary when dealing with hypermobile types of spines, as it enhances and strengthens physiological locking through the enforced compression and added friction induced. Vertex pressure with the operator's abdomen at right angle to the planes of the articulation gives the desired effect.

5. **Adjustment:** The last step in the adjustive procedure is a slight rotary thrust upward, forward, medialward and parallel to the planes of the articulation. This force is directed against the objective after the cervical spine is in a

completed state of combined anatomical and physiological locking.

Concomitantly with the adjustive force slight exaggeration of the side-bending reverse rotation is made. The concentration of this force is at the point of lesion for two reasons: first, because the forces were primarily focalized to that point; and, second, because there can be no further dissemination of these forces upward or downward as the neighboring vertebrae are in a state of complete articular locking. In consequence this force acts in a powerfully adjunctive manner, and is an effectual and corrective leverage force directed against the articulation in lesion. This powerful lever, applied with a minimum amount of adjustive force, gives a maximum of efficiency with a minimum of strain and velocity. The adjustive force should be given so that the velocity is high but the amplitude of motion short.

From a standpoint of physics, two lever arms are available. The long lever arm is the transverse process which rotates antero-superiorly and the short lever-arm the one which rotates postero-inferiorly. Naturally the best objective will be the point of greatest leverage. In this case the mechanical advantage is such that the transverse process which rotates postero-inferiorly is the point to which direct force can be applied with the best results. The objective is therefore the combined transverse and articular processes of this side. The instrumentality of adjustive force is the operator's index or middle finger. The applied force is the thrust. With these principles in view adjustment can be carried out by direct action technique with the patient supine or in a sitting posture.

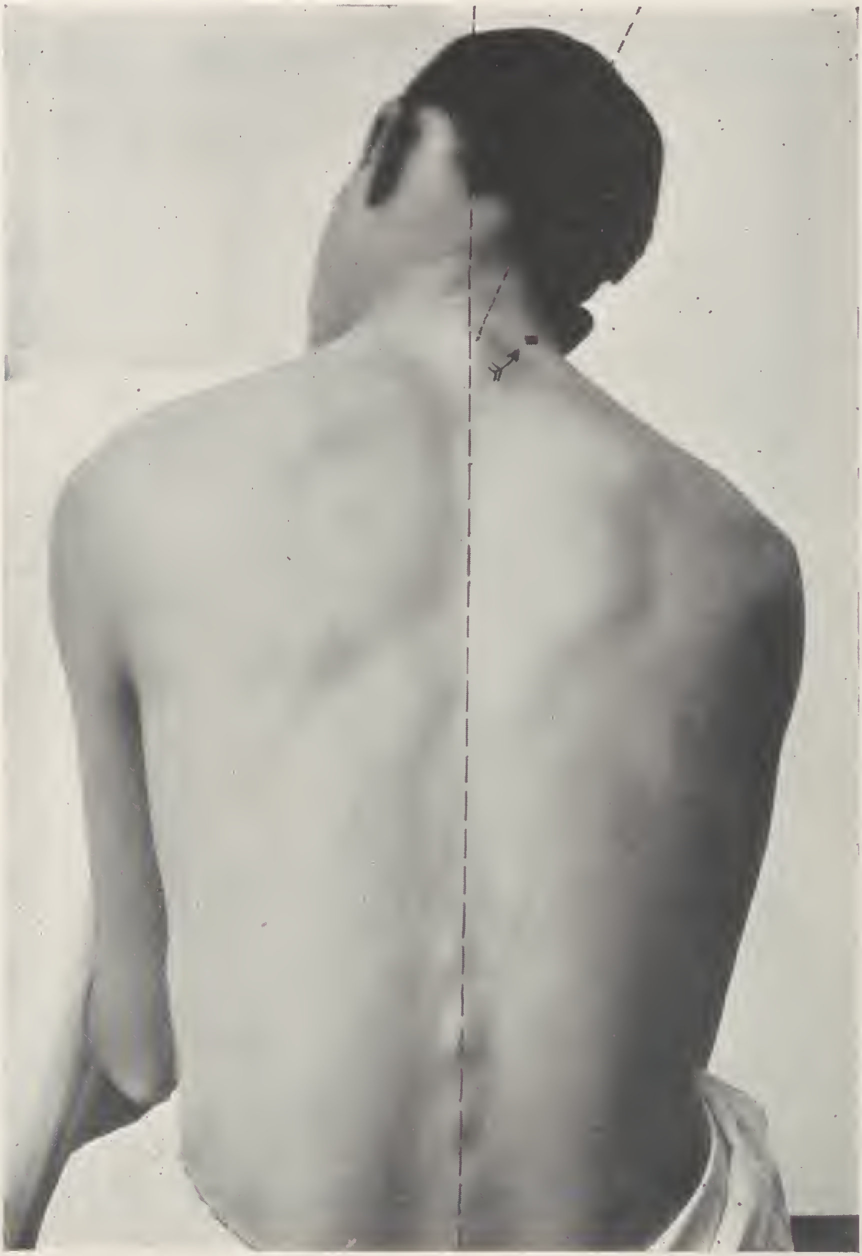
Technique of Adjustment: Consider as the hypothetical lesion a rotation side-bending lesion of the third cervical vertebra immobilized unilaterally antero-superiorly on the left, postero-inferiorly on the right. The mechanics of adjustment are as follows:

Position of hands, degrees of side-bending, and direction of reverse rotation for adjustment of a fourth cervical vertebra immobilized in rotation side-bending to the left. Side-bending determines physical restriction, reverse rotation physiologic restriction, and combined they insure articular or physiologic locking. Buckling or yielding of the flexible column is prevented by the complete muscular opposition of side-bending to that of reverse rotation. This determines rigidity and stability of the column and checks yielding strain of soft parts.

1. The erect position (neither flexion nor extension).
2. Side-bending to the side unilaterally postero-inferior; the angle of this side-bending is approximately thirteen degrees with the midline of the body.
3. Rotation toward the side antero-superior with the rotary strain greatest at the point of lesion and conducted parallel to the planes of the articulation.
4. Approximation, if necessary. Adjust with simultaneous utilization of adjustive and leverage-force.

While the adjustive hand delivers adjustive force to the vertebra in lesion, the opposite hand accomplishes several important functions. It is so placed as to support and protect the cervical vertebrae above the point of lesion and acts more or less as a splint to the lateral aspect of the cervical column. It aids and largely controls the act of physiological locking in side-bending rotation and when locking is arrived at further exercise of the physiological movements comprising this locking constitutes leverage force.

Technique No. 1: Direct Action Technique: Patient supine. The objective is the transverse process which has rotated posteriorly. The instrumentality of force is the lateral aspect of the index finger of the right hand (adjustive hand). The head and cervical column is maintained in the erect position, side-bent to the side unilaterally posterior (right) and rotated toward the side unilaterally anterior (left). The left hand is placed along the lateral aspect of the cervical column of the left side. Rotary adjustive force is delivered against the combined transverse and articular processes of the third cervical on the right side. At the same time the left hand coordinates with it in such a way as to insure counter-force and exaggerate leverage force which is accomplished by slight increase of the side-bending and reverse rotation.



Position for adjustment of a seventh cervical vertebra immobilized in rotation side-bending to the right. The objective is the transverse process fixed postero-inferiorly on the left. The anatomical locking of flexion locks the upper cervical and merges into the physiologic locking of the lower cervical obtained by side-bending to the side posterior and reverse rotation to the side anterior. With the cervical column completely locked, a leverage mechanism is assured. Superimpose to leverage force adjustive force against the objective in an upward, forward and medialward direction, parallel to the planes of the articulation.

Technique No. 2. Direct Action Technique: Patient sitting. The operator stands facing the patient on the side opposite that on which the transverse process is posterior. The palmar aspect of the slightly flexed middle finger is placed firmly against the unilaterally posterior transverse and articular processes, while the patient rests his head upon the hypothenar eminence of the same hand (left hand). The right hand of the operator is placed along the left lateral aspect of the cervical column for the maintenance of counterforce and exaggeration of leverage force. The left hand delivers the adjustive force. The physiological movements of side-bending to the side posterior, and rotation toward the side anterior with the cervical column in the erect position, (neither flexion nor extension) must be completed before adjustment is attempted.

Adjustment by Indirect Action Technique: Indirect methods are not as easily controlled as direct methods. For ease of accomplishment and specificity, direct action technique is much to be preferred. The adjustment may be accomplished with the patient either sitting or supine. The object in mind is to maintain a fixation of the vertebra below the one in lesion, on the same side the lesioned vertebra has rotated upward and forward. This is accomplished by maintaining counter pressure against the articular and transverse processes of the vertebra below the one in lesion on that side. Next, retrace the pathway of lesion movement by rotation of the head and cervical column toward the anterior side. Side-bending should be maintained throughout this procedure toward the side which is unilaterally posterior.

The Flexion Lesion: A cervical vertebra, second to the seventh, inclusive, whose inferior articular facets are maintained bilaterally anterior is a flexion lesion. There is approximation of the spinous and transverse processes of the vertebra in lesion with those of the vertebra above and corresponding separation with those

Position for adjustment of a fifth cervical vertebra immobilized in rotation side-bending to the left. F indicates degree of flexion, S indicates focalization of side-bending to the point of lesion. Arrow indicates direction of corrective force of rotation.

of the vertebra below. This lesion may occur singly but is usually found as a group lesion, counterbalancing or compensatory in character. If a compensatory group lesion, producing a straightening of the cervical curve, correct the etiological factors, inasmuch as cervical vertebrae in this case are not in an immobilized state and their position is an assumed one, due to muscular influences. If found singly correct with indirect action technique heretofore described, adjusting first one side, then the other. These lesions are rarely found and are confined to the lower cervical region, usually the sixth or seventh cervical.

The Extension Lesion: A cervical vertebra, second to the seventh, inclusive, whose inferior articular facets are maintained bilaterally posterior is an extension lesion. The amount of articular movement is relatively less in comparison to that found in the flexion type of lesion. The transverse and spinous processes of the lesioned vertebra are approximated with those of the vertebra below. The obliquity of the plane of the spinous process is increased, consequently the process is less prominent and more impalpable posteriorly. Normal separation from the vertebra above is increased. This lesion may occur singly but more often is found as a group lesion when accentuation of the cervical curve is demanded for purposes of counter balance. If found singly, correct unilaterally, first one side then the other, by strong obliteration of the cervical curve nearly to the point of locking, then using a modification of direct action technique, heretofore described.

Dislocation of a Cervical Vertebra: Dislocations of the lower six cervical vertebrae are the most common dislocations of the spine, and the articulations between the fourth and fifth, and the fifth and sixth segments are most frequently involved. Diastasis or rupture of the ligaments may be complicating fac-

Position of hands and patient for adjustment of a fifth cervical vertebra immobilized in rotation side-bending to the right. Middle finger of adjustive hand is placed firmly against the articular process which is postero-inferior. Opposite hand is placed along the lateral cervical column to splint, support and protect the area. It also controls largely side-bending and reverse rotation which together enforce physiologic locking of the area. After completion of this locking, exaggeration of these physiologic moves determines leverage force as a result of the automatic transition which follows.

tors. The bilateral and unilateral forward displacements are the more common, and the bilateral backward and the bilateral in opposite directions less frequent. Dislocation may occur with or without cord symptoms. Movements of the neck are usually extremely painful and the deformity is obvious, although the X-ray is the only means of differential determination as to whether the condition is a fracture or dislocation. Treatment should consist of hyper-extension and immobilization with a collar.

CHAPTER VII.

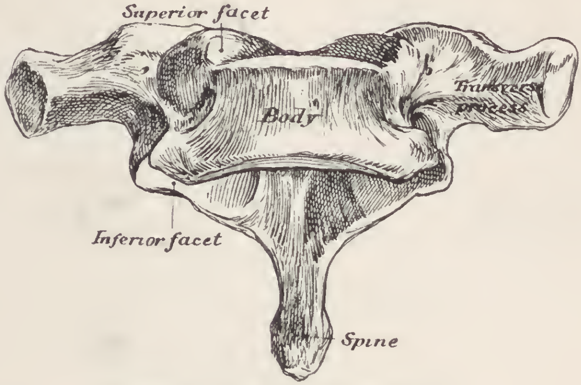
SUBLUXATIONS OF THE THORACIC VERTEBRAE

Applied Anatomy: The typical thoracic vertebrae are intermediate in size to those of the cervical and lumbar regions and increase in bulk from above downward. The most distinguishing features of these vertebrae are the depressions on the bodies and transverse processes, respectively, for the reception of the heads and tubercles of the ribs.

The bodies of the thoracic vertebrae simulate those of the cervical and lumbar vertebrae at their respective ends. The intermediate members are heart-shaped, thicker behind than in front, and approximately the same width in both their anterio-posterior and transverse diameters. The pedicles face backward and the inferior intervertebral notches are large and deep. The laminae are broad, thick and overlap one another. The spinous processes are long, directed obliquely downward and end in tuberculated extremities. The superior articular facets face backward and somewhat upward and lateralward. The inferior articular facets face forward, downward and medialward. The transverse processes are thick, strong and project obliquely backward and lateralward. The inferior articular processes of the twelfth thoracic vertebra are convex and turned outward, partaking of the nature of those of the lumbar vertebrae.

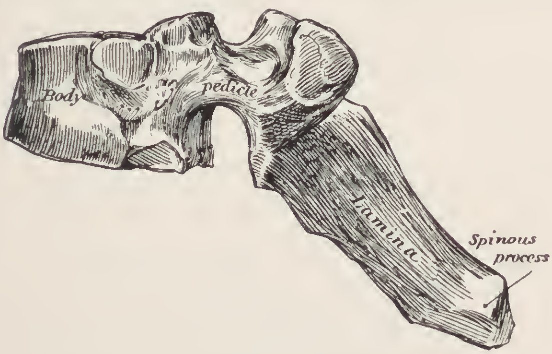
The thoracic curve, which is primarily concave forward, commences at approximately the middle of the second and terminates at approximately the middle of the twelfth thoracic vertebrae. This posterior convexity is due largely to the fact that the bodies of the vertebrae are slightly thicker behind than in front.

Thoracic Vertebral Articulations: The different segments of the thoracic column are connected by spinal ligaments similar to those of the cervical and lumbar regions. The ligaments connecting



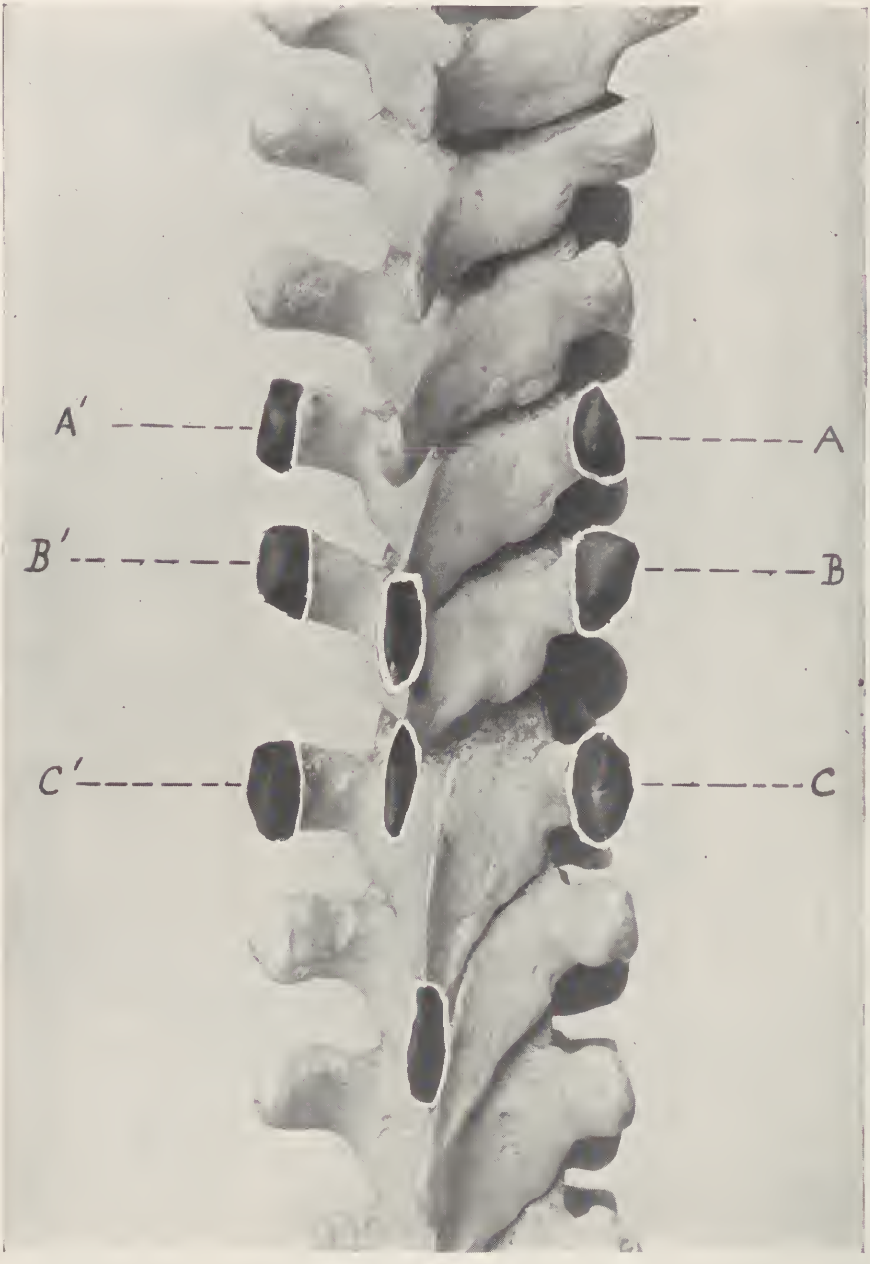
Thoracic vertebra, anterior view.

the bodies of the vertebrae are the anterior common ligament, the posterior common ligament and the intervertebral fibro-cartilage or disc. Those connecting the laminae are the ligamenta subflava. The transverse processes are connected by the inter-transverse ligaments. Those connecting the articular processes are called the capsular ligaments. They are lined on their inner surface with synovial membranes and form double arthrodia, superiorly and inferiorly.



Lateral view of typical thoracic vertebra.

All movements of the thoracic vertebrae are restricted to reduce interference with respiration. The almost complete absence of an upward inclination of the superior articular facets prohibits any marked flexion, while extension is checked by bony contact limitation of the inferior articular margins with the laminae, the approximation of the spinous processes with one another and the tension in the anterior common ligament.

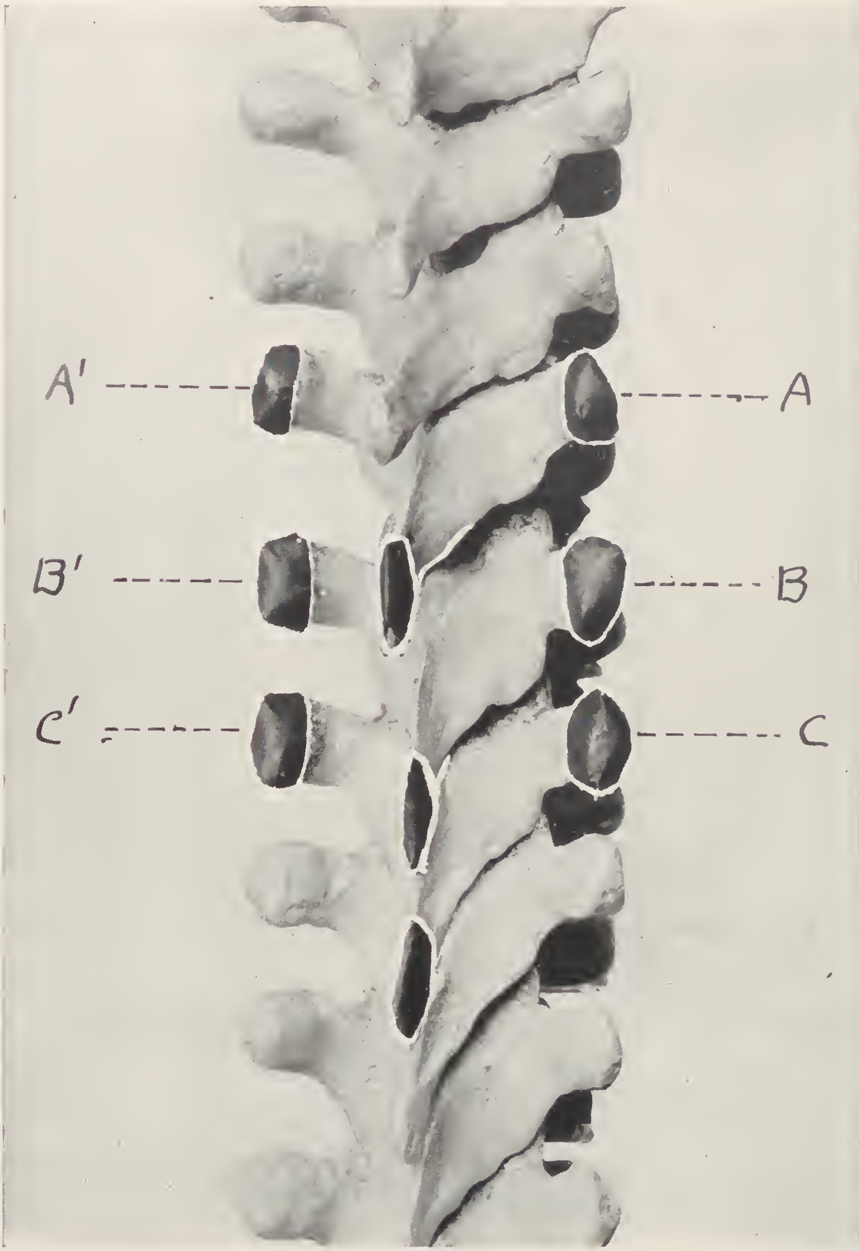


Demonstrating position assumed by vertebra immobilized in flexion. Note aproximation of transverse processes of vertebra BB' to those of vertebra above, AA', and separation from those of vertebra below CC'. Note increased obliquity spinous process of the vertebra involved and its increased prominence posteriorly. Buckling of the yielding column is apparent so that the vertebra is en masse posterior, although the inferior articular facets have moved bilaterally upward and forward on those of the vertebra below.

The Intervertebral Substance: The outer portion is composed of a large number of concentric layers of fibrous connective tissue. This enveloping portion is called the annulus fibrosus. The central portion is a soft, pulpy mass of highly elastic fibro-cartilage and is in a greatly compressed state. It is called the nucleus pulposus and is embryological vestige of the notochord. It acts as a ball-bearing mechanism and is the fulcrum for the greater percentage of movement of the bodies of the vertebrae.

Flexion: Any movement of the column which describes a forward arc of motion is designated flexion. In this movement the anterior common ligament is relaxed and the intervertebral substance is compressed in front; while the posterior common ligament, ligamenta subflava, and the inter- and supra-spinous ligaments are stretched, together with the posterior fibers of the intervertebral disc. The interspaces between the laminae are widened and the inferior articular processes of the vertebra above glide upward on the superior articular processes of the vertebra below. Flexion is the most extensive of all the movements of the vertebral column. The thoracic spine is the first to lock in extension and the last to lock in extreme flexion of the entire spine. Flexion is freer in the lower thoracic than any other portion of the region.

Extension: This movement is the converse of flexion in that there is an exactly opposite disposition of parts. The movement is limited to a greater relative extent than flexion by the anterior common ligament and bony contact limitation. The inferior border of each articular process comes in contact with the lamina of the vertebra below. There is an approximation of the spinous processes and to a lesser degree the transverse processes. Extension is extremely limited in the thoracic area, particularly in the mid and upper thoracic regions and has its freest range of motion in the lower thoracic area.



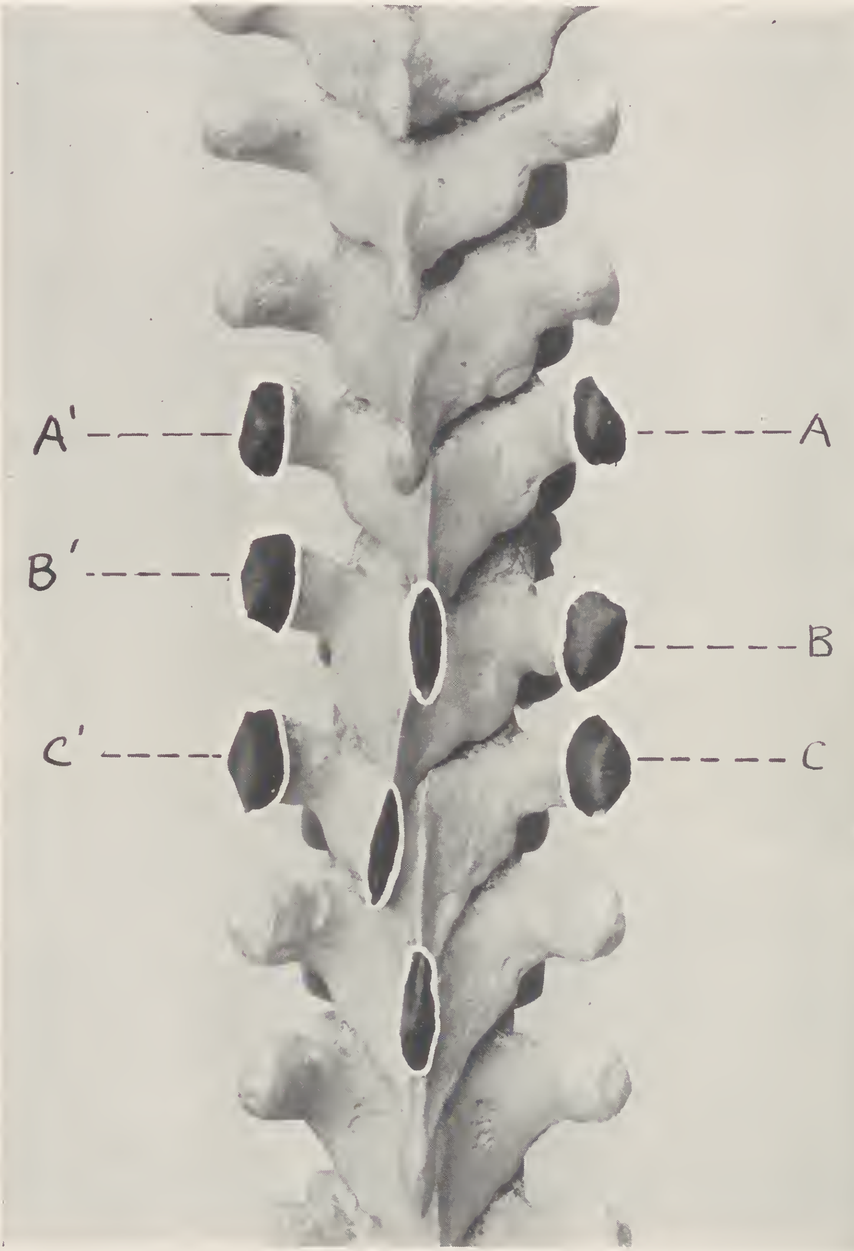
Demonstrating position assumed by vertebra immobilized in extension. Note approximation of transverse processes of vertebra BB′ to those of vertebra below CC′, and separation from those of vertebra above AA′. Note increased obliquity of spinous process of the vertebra involved and its lessened prominence posteriorly. Buckling of the yielding column is such that the vertebra is en masse anterior, although the inferior articular facets have moved bilaterally downward and backward on those of the vertebra below.

Side-bending or Lateral Flexion: The intervertebral discs are compressed laterally and motion is limited by the resistance of the surrounding ligaments and also by approximation of the transverse processes. Side-bending is freer in the lower thoracic than in any other portion of the dorsal spine.

Rotation: This movement is quite free around a vertical axis drawn along the mid-ventral line of the bodies of the vertebrae. The movement is produced by a slight torsion of the intervertebral substance. This, although slight between any two vertebrae, produces considerable range of motion when taking place throughout the entire length of the column. Rotation is most pronounced in the upper part of the thoracic column.

The cervical column enjoys the greatest degree of each variety of movement. In the thoracic region all movements are limited, particularly in the mid-dorsal. In the lumbar area motion is free with the exception of rotation.

Side-bending Rotation: These movements are invariably combined and one never occurs without the other, yet the direction and amount of each varies, depending upon which is the primary movement. In the above case, when side-bending is primary, rotation of the body is limited by the opposing action of the two physiological movements, providing obvious rotation is attempted in an opposite direction to that of the side-bending. Regardless of whether the side-bending is primary or secondary, if the rotation is attempted toward the same side as the lateral flexion, the body of the vertebra will rotate toward the concavity of the curve. The bodies of the vertebrae will act differently under varying degrees of flexion or extension and depending upon whether or not the movement is voluntary or passively enforced. In side-bending reverse rotation in which the patient is side-bent toward one side primarily and rotated toward the opposite side secondarily, a slight tend-

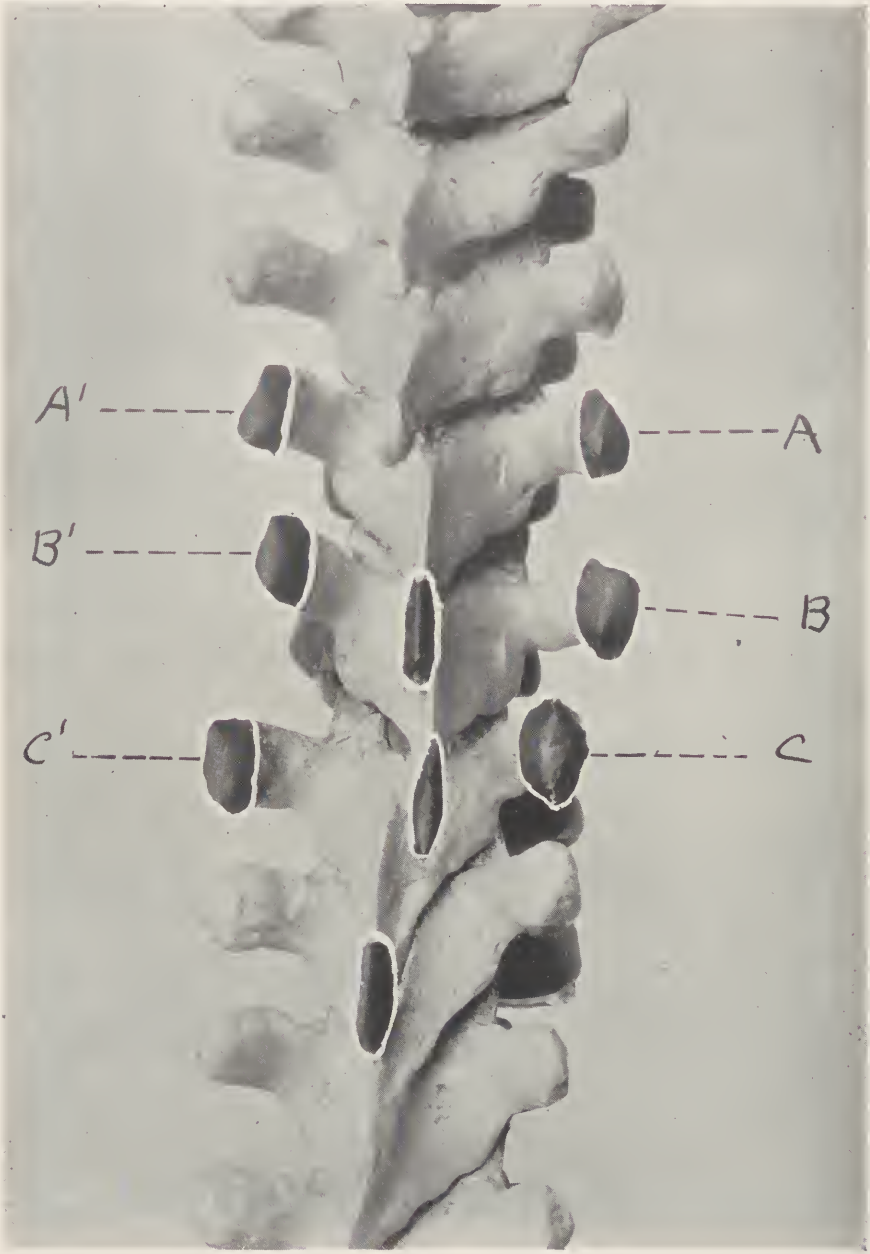


Demonstrating position assumed by vertebra immobilized in ordinary rotation side-bending, or side-bending rotation. Note postero-inferior position of right transverse process B and antero-superior position of left transverse process B′. The spinous process is deviated to the left. This lesion is a combination of the physiologic movements of rotation and side-bending to the right. These movements are inseparable, although in varying proportions. This is a common type of subluxation.

ency to rotation of the body toward the convexity of the curve is noted, provided the spine is in the erect position, easy flexion or easy extension. In voluntary movements in which the patient himself attempts side-bending to one side and rotation toward the opposite side, the tendency is to lock the bodies of the vertebrae in the midline by the opposing action of the two forces, except when the spine is in flexion, in which case the bodies of the vertebrae of the upper mid-dorsal area can rotate slightly toward the convexity of the curve.

In passive movements, when side-bending is alone induced, the tendency is for the bodies of the vertebrae to rotate slightly toward the concavity of the curve. In voluntary side-bending on the part of the patient, the possibility of any tendency to rotation of the bodies of the vertebrae toward the convexity is questionable unless an obviously forcible attempt is made by the patient to rotate his body toward the side opposite that of side-bending.

In conclusion it may be stated that a tendency for rotation of the bodies of the vertebrae toward the convexity of the curve is possible in passive movements when the patient is obviously side-bent to one side primarily and secondarily rotated to the other; and this only in case the spine is neither locked anatomically in hyperflexion or extension. In voluntary movement when primary side-bending is followed by a secondary attempt at rotation toward the side opposite that of the lateral flexion the body of the vertebra tends to remain in the midline or rotate slightly toward the concavity except with the spine in hyperflexion in which case there is a slight rotation of the upper mid-dorsal toward the convexity. In a general way the element of rotation is greater when the spine is in extension and the percentage of side-bending correspondingly increases with the spine in flexion although this is not a hard and fast rule.



Demonstrating position assumed by vertebra immobilized in side-bending rotation. B′ indicates postero-superior position of left transverse process. B indicates antero-inferior position of right transverse process. Slight deviation of the spinous process to the right may or may not be noted. Primary side-bending to the right is followed by secondary rotation to the left and is consequently a movement of side-bending, secondary reverse rotation. This lesion is found only in combination with flexion and is confined to the upper mid-dorsal.

Lesions of the Thoracic Vertebrae:
1. Flexion Lesion.
2. Extension Lesion.
3. Rotation Side-bending Lesion.
4. Side-bending Rotation Lesion.

The Flexion Lesion (Syn. Bilaterally Anterior Lesion).

The flexion lesion is an immobilization of the vertebra in the position of flexion. It is bilaterally anterior if considered from the relative change in position of the inferior articular facets of the vertebra in lesion upon the superior of the vertebra below. However, from its relative disposition in the dorsal column and because the obliquity of the spinous process is decreased and the convexity of the thoracic curve increased, it is relatively more prominent posteriorly, and is therefore considered by many as an en masse posterior lesion. It may be single or in group formation in which latter case it results in the production of a so-called dorsal kyphosis.

Etiology: Trauma, sudden strains, particularly with the dorsal spine in flexion, and the lifting of heavy weights are some of the causes of individual lesions. The group lesion is usually occasioned by a gradual process extending over a long period of time. Occupational and faulty postural habits, general atonicity of the extensor muscles, hypertonicity of the flexors, etc., are examples of its predisposing factors. The larger percentage of individual lesions are the results of reciprocal innervation. A small percentage of lesions are the result of infection.

Diagnosis: The spinous process of the vertebra in lesion is less oblique, therefore relatively more posterior; and, moreover, it is separated from that of the vertebra below and approximated with that of the vertebra above. Restriction of motion upon the vertebra below is such that the degree of separation of the spinous processes cannot be changed either by flexion or extension. Movement is free between the vertebra in lesion and the one above,

although there is approximation of the spinous processes. The articular facets have moved bilaterally upward and forward, and there is some separation of the articular surfaces posteriorly, due to the tipping and different level maintained by the vertebra in lesion. The transverse processes and laminae of the vertebra in lesion are slightly separated from those of the vertebra below. The posterior ligaments are stretched, thinned and atrophied, and the anterior are thickened and shortened. The body of the vertebra is slightly tilted and the articular facets are not in parallel planes. The intervertebral disc is compressed anteriorly and decompressed posteriorly.

The Extension Lesion: (Bilaterally Posterior Lesion). The extension lesion is an immobilization of the vertebra in the position of extension. It is bilaterally posterior if considered from the relative position of the inferior articular facets of the vertebra in lesion upon the superior of the vertebra below. From its relative disposition in the dorsal column, namely, because of the increased obliquity of the spinous process and the decreased convexity of the thoracic curve at the point of lesion, it is often considered as an en masse anterior lesion. It is relatively less prominent anteriorly and may be single or in group formation. In the latter case the condition is termed a dorsal lordosis.

The fulcrum upon which this movement takes place is the nucleus pulposus of the intervertebral disc which is the same pivot utilized in flexion.

Etiology: Trauma or sudden strain, particularly with the dorsal spine in extension, are the causes of the primary type of individual lesion. The group lesion is usually secondary and compensatory in character for some flexion condition elsewhere, a typical example of which is the straight spine. A larger percentage of indivi-

dual lesions are the result of reciprocal innervation. A considerable number are traumatic and a very small proportion are the result of infection.

Diagnosis: The spinous process of the vertebra in lesion is more oblique and relatively less prominent posteriorly. It is separated from that of the vertebra above and approximated to that of the vertebra below. Motion is restricted where there is approximation; in other words, with the vertebra below; and free where there is separation, or with the vertebra above. The articular facets have moved bilaterally downward and backward and the transverse processes and laminae of the vertebra in lesion are approximated to their respective neighbors on the vertebra below. In the chronic group lesion the anterior ligaments are stretched and weakened and the posterior shortened and thickened, with corresponding muscular changes.

Rotation Side-bending Lesion: The rotation side-bending lesion is a subluxation of a vertebra in primary rotation, secondary side-bending in which the vertebra is maintained in rotation to the concavity of the curve. Physiological movement in which rotation side-bending, or side-bending rotation is such that both have been made toward the same side, will result in rotation of the bodies toward the concavity of the curve. Regardless of whether side-bending or rotation is primary, if the attempted physiological act is to side-bend in one direction and rotate the other, the opposing action of the forces will serve to limit both acts, but particularly that of rotation. From the varying conditions of flexion or extension the body then rotates toward the convexity but not to any appreciable degree unless the secondary rotation is reversed to that of the side-bending and the spine is in hyper-flexion.

Side-bending Rotation Lesion: The side-bending rotation lesion is a lesion maintained in primary side-bending and secondary rotation with the rotation in the reverse direction to that of side-bending. This lesion is rare and occurs under peculiar forces of torsion or trauma with the thoracic spine in hyperflexion. The nearest approach to it physiologically is side-bending to one side, and obviously attempting rotation toward the opposite side from a flexed position.

Differential Diagnosis:

Third Dorsal Sidebent to Right:	**Third Dorsal Rotated to Right:**
1. Vertebra is tilted to right.	1. Vertebra is tilted to the right.
2. Spinous process deviated to the right (concavity).	2. Spinous process deviated to the left (or toward the convexity).
3. Body rotated to the left toward convexity.	3. Body rotated to the right (toward concavity).
4. Right transverse process moves downward.	4. Right transverse process moves downward and backward.
5. Left transverse process moves upward and backward.	5. Left transverse process moves upward and forward.
6. Left third rib is posterior and approximated to rib above.	6. Left third rib anterior and approximated to rib above.
7. Right third rib relatively anterior and approximated to rib below.	7. Right third rib relatively posterior and approximated to rib below.
8. Intervertebral disc is compressed on the right.	8. Intervertebral disc is compressed on the right.
9. Occurs usually in flexion with strong sidebending to right, secondary rotation to left.	9. Comprises the vast majority of lesions involving rotation and sidebending, or sidebending and rotation.

The main point to remember in the differential diagnosis between the two types of lesion is that in rotation, for instance to the right, there is tilting and rotation to the right; and in side-bending to the right, a tilting to the right, but a rotation

Demonstrating rotation side-bending of the dorsal column. Rotation of the lumbar vertebrae does not show up. It must be borne in mind that in all instances rotation of the lumbar vertebrae is extremely restricted.

to the left. Moreover, that in the former the right transverse process is the most prominent and in the latter the left is the most prominent.

The possibility of the side-bending rotation lesion being an etiological factor by allowing of a certain amount of predisposition to a lateral curvature of the organic type is a reasonable supposition, although it is not a substantial fact.

Principles of Adjustment of the Upper Dorsal: For the matters of convenience adjustment is subdivided into those methods for the upper dorsal and those for the mid- and lower dorsal areas. There are three basic types of adjustive mechanics for reduction of upper dorsal subluxations: (a) Methods utilizing cervical leverage, (b) Methods utilizing physiological locking, (c) Methods using direct force, with neither physiological locking nor cervical leverage, but occasionally combined with anatomical locking.

Principles for the Use of Cervical Leverage: In using the cervical column for adjustment of upper dorsal lesions of the rotation side-bending, or the side-bending rotation types, certain definite principles must be fulfilled in order that the cervical column may be thoroughly locked against possible strain or injury, and may, moreover, act as a unit lever-handle to bring the maximum amount of leverage force of a corrective nature upon the vertebra in lesion. The principles involved necessitate the use of the physiological movements of extension, side-bending and rotation.

Extension is the primary move and is required to fulfill two necessary laws: first, that of protection because extension locks the lower cervical column anatomically; and, secondly, unification of the lever handle so that the involved series of articulations can be used effectively as such.

The next movement is side-bending and should be toward the side unilaterally antero-superior in the case of the rotation lesion and the postero-superior side in the case of the side-bending lesion; and in both cases toward the side on which the transverse process is uppermost. The degree of side-bending should be approximately 10 degrees with the midline of the body and the apex of the angle of this side-bending should occur at the point of lesion.

The third movement is that of reverse rotation, or, in other words, rotation toward the postero-inferior side in the case of the rotation lesion and antero-inferior side in case of the side-bending lesion; and in both instances toward the side on which the transverse process is at a relatively lower level than its opposite fellow. This reverse rotation brings about separational strain of the articular facets, particularly on the side on which the transverse process is downward. It also brings tension leverage in an upward direction on the same side, through the semispinalis cervicis and capitis, the longissimus cervicis and capitis and associated muscular tension pulls. It also serves to steady and further lock the cervical column, particularly the upper cervical, and give greater stabilization and resistance to adjustive force at the point of lesion.

Varying amounts and degrees of these combined physiological movements are necessary to direct their focalized effect specifically to the point of lesion. It may be said in a general way that the lower in the dorsal column the lesion occurs, the greater the amount of extension, the wider the sweep of side-bending, the longer the resultant lever-handle and the greater the arc of reverse rotation.

Cervical leverage is effective when utilized for adjustment of vertebral subluxations in the upper dorsal spine. In no instance should it be carried to the degree of strain necessary to focalize its forces to lesions beyond its proper sphere of activity. It should never be utilized for lesions below the

seventh dorsal and then only when certain types of technical procedure are used.

Methods Utilizing Cervical Leverage:

Technique No. 1. Patient sitting, hypothetical lesion of the third dorsal, rotated unilaterally antero-superior on the right, postero-inferior on the left (rotation lesion on the left). Patient sits on a stool and the operator on the table facing the patient's back. The operator places the thumb of his right hand against the convex, or in other words, the right side of the spinous process of the vertebra in lesion. The patient's left axilla rests over the operator's flexed knee and he is side-bent to that side. The operator's left foot is placed on the stool beside the patient with the knee in flexion, to allow for the above movement. The patient's torso is side-bent and the cervical column together with that portion of the upper dorsal column entering into the long lever-handle is brought back to a vertical plane, thereby enforcing the principal of side-bending to the antero-superior side; and, moreover, effecting this in such a manner as to allow the operator to work with the greatest mechanical advantage and with a more unified counter-resistance to his adjustive efforts. With the cervical column in extension and with side-bending completed, the last physiological movement of reverse rotation additionally focalizes gerater leverage force at the point of lesion. Occasionally the operator can make complete circumduction of the patient's head, ending with the head and cervical column in position of side-bending to the right, extension and rotation to the left, thereby arriving at the same point with a slightly greater leverage tension. The patient's right arm should hang limply over the left thigh, so as to allow the shoulder girdle of that side to be thoroughly relaxed at the moment of adjustment. Occasionally it is necessary to ask the patient to allow the shoulder-girdle to sag. The opposite shoulder gives no trouble and it is not necessary to demand relaxation of the patient for that particular side. Adjust with slight exaggera-

tion of leverage force; or, more explicitly, with slight forcible increase of side-bending and reverse rotation and simultaneous transverse force against the right side of the spinous process of the vertebra in lesion with the thumb of the right hand. This force is directed transversely to the left.

Technique No. 2. With the patient sitting on the treatment table, his back to the operator, the above method, modified, is equally efficient. Instead of side-bending the patient so that the axilla rests over the flexed knee, the patient is side-bent, but not so completely as to be off balance. What little stabilization is necessary can be rendered by the operator by slightly leaning against the patient's torso. The physiological movements of extension and reverse rotation further complete the leverage force. It is always wise to make it a point to place the fingers of the left hand on the vertex of the head, resting at this point in such a position as to control reverse rotation and allow the full length of the flexed forearm to rest along the left lateral aspect of the cervical column in such a way as to protect it in a splint-like manner. The lower portion of the forearm rests lightly on the shoulder and is closely approximated to the root of the neck. This protective mechanism is of great value in that it prevents all possible strain, and still further unifies and steadies the lever handle effect of the column. This protection of the lateral aspect of the cervical column is necessary both for protective purposes and control of leverage action; and it must be used.

Technique No. 3. With the patient sitting, and the objective the transverse process which is postero-inferior instead of the convex side of the spinous process. The instrumentality of force is the pisiform bone of the proximal hand and the applied force is directed upward, forward, and slightly lateralward. The opposite hand is placed over the vertex of the head, and the flexed forearm along the side of the head and the lateral cervical column with the semi-flexed elbow resting lightly on the shoulder at its junction with the root of the

Position for adjustment of a first dorsal vertebral subluxation immobilized in rotation side-bending to the left. Extension of the cervical column, side-bending to the side unilaterally anterior and rotation to the side unilaterally posterior (arrow B). Arrow A indicates direction of transverse adjustive force against convex side of spinous process.

neck. Extend the head and cervical column and follow with side-bending toward the antero-superior side and reverse rotation or rotation toward the postero-inferior side. Adjust with sudden vigorous thrust against the transverse process of the vertebra in lesion together with concomitant exaggeration of leverage force.

Technique No. 4. Another very good method for the adjustment of this particular type of lesion is as follows:

Assuming the same hypothetical lesion, the third dorsal rotated unilaterally antero-superior on the right, postero-inferior on the left, the patient is made to lie on the left side. The right arm is dropped over the edge of the table, and held between the operator's knees, so as to enforce stabilization of the right side of the shoulder girdle. The left shoulder, which is in contact with the table, is sufficiently stabilized by superincumbent weight. The objective is the convex side of the spinous process or, in other words, the right side. The thumb of the operator's left hand is placed firmly against this objective. The head and cervical column are extended, side-bent to the right and rotated to the left. The operator's left hand is placed firmly against the left lateral aspect of the root of the neck, and the forearm against the left lateral aspect of the upper cervical column and side of the head. Adjustment is completed with exaggeration of leverage-force and simultaneous spinal transverse force directed to the left against the convex side of the spinous process.

Technique No. 5. Patient prone. The same hypothetical lesion is to be corrected. The chin is tilted forward, acting as a pivot and incidentally serving in such a manner as to enforce extension of the occiput and cervical column. The next physiological movement is that of side-bending, which should be carried to the right and closely followed by reverse rotation, or rotation to the left, the chin acting as the pivot for this movement. Protect the occiput and lateral cervical column on the left side with the left hand and forearm and control leverage force by this same anatomical mechanism. Op-

Position for adjustment of a second dorsal vertebra immobilized in rotation side-bending to the right. Cervical leverage consists of extension followed by side-bending to the side unilaterally anterior and rotation toward the side unilaterally posterior. Arrow A indicates the direction toward which the occiput rotates. Arrow B indicates the direction in which corrective force is directed against the convex side of the spinous process. Arrow C indicates the direction toward which the column is side-bent.

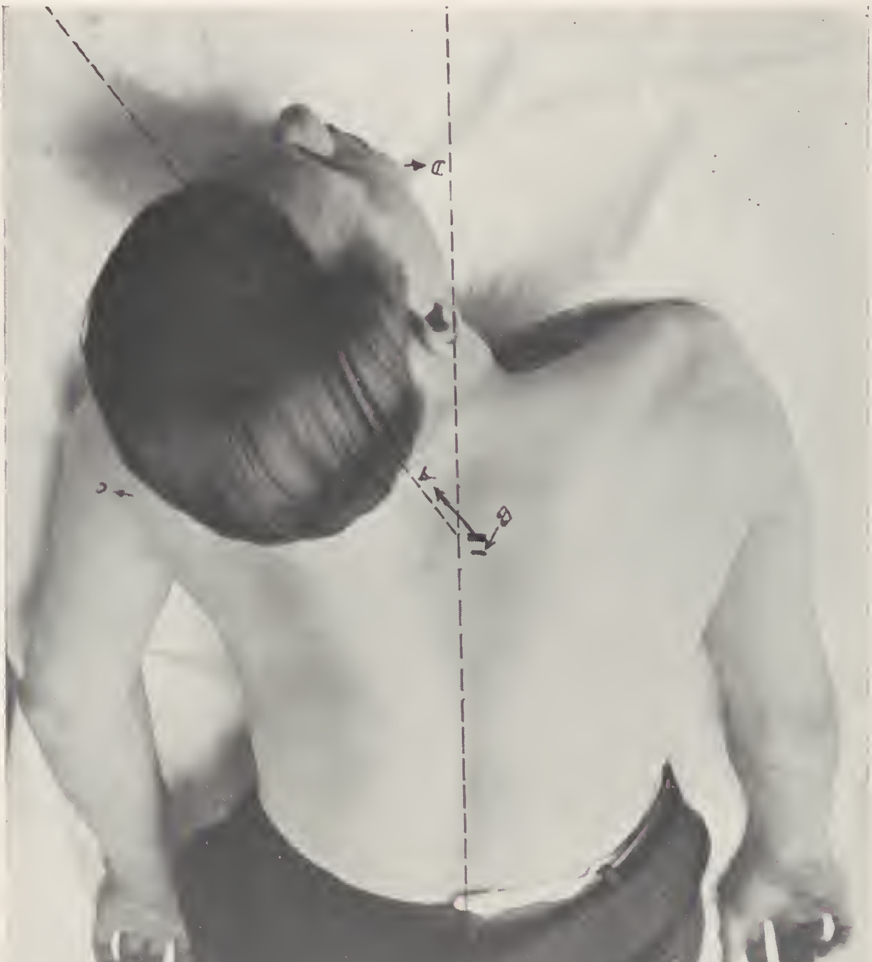
pose leverage force by counter adjustive force directed against the transverse process of the vertebra below the one in lesion on the left side and at right angles to the plane of the articulation.

Technique No. 6 . The above technique may be modified in such a way as to be particularly applicable to the first and second dorsal, in contradistinction to the above technique, the applicability of which is greater lower down in the dorsal column. In fact, Technique No. 5 can be used effectively as low down as the seventh, which is very much the exception, as the other methods described should not be used below the fourth.

If the chin is not used as a pivot and the patient is allowed to rest on the side of the face with his cervical column in a position of easy extension, side-bending and reverse rotation, the focalized leverage force is peculiarly effective to the first and second dorsal. In this technique the objective is the convex side of the spinous process and adjustive force is directed transversely. The occiput and lateral cervical column must be protected by proper placement of the operator's hand and leverage force must be controlled by this same anatomical mechanism.

Principles for the Use of Physiological Locking: Physiological locking may be utilized for all lesions partaking of the nature of rotation side-bending, or side-bending rotation from the third dorsal to the twelfth dorsal, inclusive. As in the cervical column it must be very exactly secured and maintained.

Extension is the primary move. In fact, if extension is exaggerated it results in anatomical locking. But as utilized for physiological locking, it is not of sufficient degree to enforce the above type of locking but only a slight physiologic limitation. The next move is that of side-bending and the acute lateral flexure should be at the point of lesion, which



Position for adjustment of a third dorsal vertebra immobilized in rotation side-bending to the right. Extension, side-bending and reverse rotation of the cervical column comprise leverage mechanism. The chin acts as a pivot. Arrow D shows direction in which chin points and arrow C the direction that occiput points. Arrow A indicates direction of leverage force, arrow B indicates transverse process of the vertebra immediately below the one in lesion and indicates direction for counter adjustive force.

is the junction of the midline of the body and the laterally inclined upper torso. Apposition of facet surfaces is absolutely essential to the production of articular or physiological locking. Forced tissue tension locking is not physiological locking. Without this apposition of facet surfaces the capsular ligaments are endangered and are subject to injury if placed on tension, which is apt to result if physiological locking is incorrectly accomplished. This may produce rupture, capillary hemorrhage, and other associated injuries. Side-bending is necessary in that it places the articular facets in such position that their inherent mechanics are evoked by a correct combination of physiological moves with the ultimate effect that enforced limitation ensues in a certain definite direction without forced tension of capsular ligaments and other adjacent tissues, muscular or ligamentous. And, moreover, this enforced limitation of movement is in the direction in which corrective force is to be applied. It serves, therefore, as one of the factors that bring about physiologic conditions by which the vertebrae above and below the lesion are amply protected against further movement. Thus the possibility of lesion production when force is applied is minimized and the force is entirely localized to the articulation in lesion. Outside of its locking principles it has the additional value of bringing about leverage force of an adjustive character. The same combination of forces which produces a locking above and below the point of lesion must carry on when locking is completed in the same general direction. And, as their focalization is greatest at the point of lesion, they carry on in the nature of leverage force so that this locking force not only serves as a locking force, but is thereafter automatically transformed into leverage force. This complete locking induces a very effective counter resistance or stabilization to adjustive force on the side against which this adjustive force is directed.

Rotation is the last of the physiological moves. It completes this locking and is directed toward the side unilaterally

antero-superior. It serves to carry the articular facets on the postero-inferior side upward and forward to their limit of motion in that direction, all arriving at a point of physiological locking except the one of the vertebra in lesion, which is immobilized postero-inferiorly on that side. It is therefore obvious that the movement is a passively enforced primary side-bending toward one side with a passively enforced, secondary reverse rotation or rotation toward the opposite side. This rotary force should be greatest at the point of lesion and sufficiently disseminated to serve to lock the vertebra and above and below the point of lesion. When locking is completed this rotary strain is then greatest at the point of lesion and thereby the leverage force which automatically ensues is greatly enhanced.

Stabilization, which is always a valuable asset in vertebral adjustment as a counter agent to adjustive force, is amply provided for by the opposed muscular tension effect of side-bending with reverse rotation. The muscular tension pull of side-bending is completely opposed by the muscular tension effect of reverse rotation. The character of their opposition is such as to prevent strain.

Side-bending is of value inasmuch as by its approximating effect on the side unilaterally postero-inferior, it inversely gaps and brings about separational strain between the articular facets of the opposite side and as no adjustive-force is directed to this side, allows this particular lever handle to rotate downward and backward when upward, forward and medial force is directed against the opposite lever handle, the transverse process which is postero-inferior. As in the cervical column, there are two lever handles, a short and a long, and adjustive force is directed to the shorter of the two.

Demonstrating side-bending and attempted reverse rotation. These particular physiologic movements enforce physiologic locking upon the spine. Side-bending enforces physical restriction, reverse rotation physiologic restriction, and combined they determine physiologic or articular locking. The muscular action of side-bending is opposed by the muscular action of reverse rotation so that stabilization locking of the column ensues. This is a preventative to buckling or yielding of the flexible column. This complete muscular opposition is directly adjunctive to the articular locking.

Method of Adjustment Using Physiological Locking: The objective is the transverse process which is postero-inferior. The instrumentality of force is the pisiform bone. The applied force is a thrust, the velocity of which is high, but the amplitude of motion slight. Have the patient interlock the arms. The operator then passes his arm over the shoulder on the opposite side so as to rest his axilla over this point. He then passes his arm across the chest and underneath the patient's axilla on the opposite side. He interlocks his fingers and brings the pisiform bone of the opposite hand firmly against the proper transverse process of the vertebra in lesion. He then takes a long step from the side opposite the lesion to the side of lesion, thereby employing the principle of side-bending. At the same time he pivots and brings his patient into extension and rotation toward the opposite or antero-superior side, thus bringing him to a point of locking without any undue strain or effort either on his own or the patient's part. The patient should never be carried completely off balance and the operator should always keep in line with the direction of his locking and adjustive forces. He side-bends with the patient, and without any loss of side-bending proceeds with extension and reverse rotation by merely pivoting and carrying the patient into the position of locking. He is then in direct line with and at his best mechanical advantage to deliver adjustive force. With his opposite arm he also has a position which allows him to obtain an effective stabilizing resistance and leverage force with but a very slight exaggeration of extension, side-bending and reverse rotation. Adjustive force is carried upward, forward, and medialward. This particular method can be used for adjustment of any side-bending rotation or rotation side-bending lesion from the third to the twelfth dorsal, inclusive.

Illustrating on a Halladay flexible spine anatomical locking in extension of the dorsal column. This area of the spine is the first portion of the entire column to lock in extension and the last to lock in flexion.

Method of Adjustment Using Physiological Movement: This method is more complicated than that previously described and not generally as effective or accurate. It is slightly cumbersome and awkward and not as easy of accomplishment. The first step in the procedure is to exaggerate the lesion. If the lesion is an immobilization in rotation side-bending to the right with the right transverse process postero-inferior, the primary movement consists in rotation side-bending to the left. This exaggerates the lesion and brings the postero-inferior transverse process into still greater prominence. The point of the flexed knee is placed firmly against the posterior transverse process and this point of fixation acts as a fulcum and is maintained throughout the entire procedure.

Extension and rotation side-bending toward the right against the resistance of the fulcrum cause the vertebrae above and below the articulation in lesion to rotate downward and backward on the left and leaving that bone in a corrected position as the remainder break away from their fixation with the vertebra in lesion. It is obvious that a full restoration of arthrodial movement is thus indirectly brought about.

This method is effective for lesions between the fourth and the tenth dorsals. It is an indirect form of technique at best, and is not advised over those methods which utilize physiological locking. It can be best accomplished with the patient sitting on the stool and the operator on the table facing the patient's back.

Methods of Adjustment With the Patient Prone: In the last few years a lot of attention has been paid to adjustment with the patient prone, using special forms of tables. As applicable to the thoracic column there is considerable value in this particular form of technique. It has gradually been augumented so as

Position of hands for adjustment of a fifth thoracic rotation side-bending lesion to the left. Right pisiform contact is against transverse process unilaterally posterior on the left, left pisiform contact is against the transverse process unilaterally anterior on the right. Bilateral simultaneous adjustive force against both objective parallel to the planes of the articulation and concomittant breaking of fixation by force directed at right angles to the planes of the articulation is carried out. Primary breaking of fixation is obtained by force directed by the right pisiform against the transverse process below the one in lesion on the left side.

to include the cervical and lumbar columns, for which it is not particularly specific and therefore not desirable. It has been previously mentioned that the thoracic column is the first portion of the entire spinal column to lock in extension. This is an anatomical form of locking.

Importance of Proper Table Selection: Any suspension or spring table automatically brings in this locking and is therefore of value. The author utilizes particularly the Taplin pneumatic table for this purpose, for several reasons. First, because of the air shift and displacement there is not only a point of yielding, which gives a very effective locking in extension, but also above and below the point of yielding there is an automatic uplift of air pressure which still further stabilizes and increases the effectiveness of the locking. The amount of extension can be regulated by removing the cross-boards underneath the air cushion. It is an absolutely safe table to work upon inasmuch as the patient can not be brought into such severe suspension as to produce unnecessary strain or possible injury. Its mechanism is more or less fool-proof which cannot be said of the ordinary suspension or spring table, in the use of which considerable caution must be exercised. Too much adjustive force, or too great an amplitude of motion is apt to produce injury on the latter type of table, and its mechanism, moreover, is not so automatically adapted to the needs of the operator.

The cervical column should never be adjusted with the patient prone, as sufficient locking is not possible in that position, likewise, with one or two minor exceptions, adjustment of the lumbar vertebrae should not be attempted with the patient prone as it is not possible to get an efficient locking of the lumbar spine in extension.

Technique No. 1. This is a bilateral cross-hand application of force. It has a dual object: primarily a breaking of fixation between the vertebra in lesion and its adjacent fellow

Position of patient for breaking of fixation by directing force at right angles to the planes of the articulations. This force is directed against the lower of the two vertebrae entering into the fixation. Arrows B and C show direction of counter force by automatic air displacement and uplift, insuring protection of vertebrae immediately above and below the point of yielding.

and almost simultaneously with a slight shift in the objectives and the direction of forces, a retracing of the full arthrodial range of motion. One hand, with the fingers pointing toward the head, is so placed that the pisiform bone is brought into contact with the transverse process of the vertebra below the one in lesion on the side on which the transverse process of the vertebra in lesion is postero-inferior. The point of contact must be against the postero-superior aspect of this process. The opposite hand, with the fingers pointing downward, is so placed that the pisiform bone is brought into contact with the transverse process of the vertebra in lesion, which has rotated antero-superiorly. Pressure is brought to bear upon these two points at right angles to the planes of their articulations, thereby breaking fixation between the articular facets through the separative or gapping strain provoked. At the summit of this pressure a quick twist of the wrist shifts the point of attack from the transverse process of the vertebra below the one in lesion to the postero-inferior transverse process of the one in lesion and the obliquity of this force is so changed as to bring it parallel to the planes of articulation. The opposite hand does not shift its position. In other words, the same objective is maintained but the obilquity of the force is increased so that both forces are parallel to the planes of the articulation, thereby retracing full arthrodial range of motion in a direction opposite to that of the fixation. The pisiform bone which makes its shift from the transverse process below the one in lesion to the one in lesion acts somewhat in the nature of a pry. These two combined movements merge in such manner as to give the entire technique the appearance of being one maneuver only. The shift of forces must be extremely rapid although the amplitude of motion is only slight. At the termination of adjustment the operator must quickly recover. If pressure is sustained considerable strain may be evoked. All muscular tissue must respond to mechanical stimulus and the nature of that response is a contracture of its functioning elements.

All of the soft tissues have a certain amount of elasticity and the nature of their response is recoil. To block this recoil would mean strain to the patient, therefore, the operator should get away quickly from the field of operation. The older idea that recoil had some influence from the point of adjustment and that technique of this character depended upon recoil for its effective culmination is not true. The initial forces are the adjustive forces; recoil is only incidental, and the natural response of elastic and excitable soft tssues. Recoil cannot be controlled either from the nature or the direction of its influence; and moreover, it is never as great as the initial force inasmuch as natural resistance takes up a certain percentage of it. Adjustment by recoil is therefore out of the question in that it is uncontrollable and not sufficiently effectual.

Technique No. 2. -This method does not involve particularly the principle of the breaking of fixation. It consists of retracing the full arthrodial range of motion in an opposite direction to that of the fixation. The objective is the transverse process which is postero-inferior and the instrumentality of adjustive force is the pisiform bone. The direction of this adjustive force must be parallel to the plane of the articulation. Stabilization resistance is maintained with the heel of the opposite hand against the transverse processes of the three or four vertebrae above the one in lesion. This counter stabilization resistance is brought against the transverse processes of the aforesaid vertebrae in a downward, slightly lateralward direction on a side opposite to that of the objective. This, besides allowing for stabilization resistance and further increasing the effectiveness of anatomical locking in extension, evokes a certain amount of gapping strain at the point of lesion on the side on which adjustive force is to be given, thereby minimizing the amount of adjustive force necessary. Exaggeration of the counter force is carried out concomitantly with the application of adjustive force.

The direction of all forces must be such as to keep in view the natural contour of the dorsal column. Because of its natural convexity all adjustive force must be radial to a more or less fixed point and that point is approximately the center of the sternum.

Technique No. 3. This method is somewhat similar to Technique No. 2 inasmuch as the objective and instrumentality of force are the same. Stabilization resistance is maintained against the transverse process of the vertebra below the one in lesion on the side opposite to that of the objective or transverse process which is postero-inferior. It acts as a counter force to the objective force and is very efficient as such. Both forces must be carried out simultaneously to effect adjustment.

There are variations to these particular methods which may be utilized, but to my mind these are the three most effective measures for adjustment in using bilateral force and anatomical locking in extension with the patient prone. The author does not approve of the application of direct force with the use of a single point of contact, this force being delivered as a thrust without counter force or stabilization resistance and depending entirely upon the primary anatomical locking for protection. The amount of force necessary to move the vertebra under such conditions is great and considerably out of proportion to what it should be.

Technique No. 4. Breaking fixation by directing force at right angles to the planes of the articulation, this force is applied to the lower of the two vertebrae entering into the fixation. This method can be easily accomplished manually; or, if desired, with the Taplin mobilizer. And inasmuch as the removal of fixation is the primary step in the correction of any lesion, it may be advisable under certain conditions to confine all procedures to that particular end only. This is particularly true in the handling of rheumatoid arthritis, rheumatic and infectious arthritis, stubborn joint lesions and

other conditions in which joint movement parallel to the planes of articulation should not be hastened. Mere removal of the fixation will promote natural reactive processes of a beneficial character; and, by avoiding the use of friction-provoking force parallel to the planes of the articulation the joint surfaces are thereby safeguarded until such time elapses as makes full arthrodial range of motion desirable and safe.

Methods of Adjustment with the Patient Supine: This method of procedure is particularly effective in the extension and flexion types of lesion, but is also extremely effectual in the rotation side-bending or side-bending rotation lesion when modified to suit such types of lesion. There are two procedures which the author utilizes.

Technique No. 1. With the patient's fingers inter-locked behind his neck, well down on the cervical column so as to produce no undue strain, the points of the elbows are brought together. If the lesion is an extension type or an extension rotation side-bending type, then this particular method should be utilized. If straight extension, the hand is so doubled up as to bring bilateral points of contact against the transverse processes, not of the vertebra in lesion, but of the one below. The operator places his forearm against the tips of the elbows of the patient, holding both in an immobilized position and in such manner as he can utilize them as lever handles. The patient is rolled over with the operator's hand underneath, maintaining firm counter adjustive force against the vertebra below the one in lesion. Air line pressure is brought to bear upon the points of the elbow in such direction that the resultant force will pass antero-posteriorly through the vertebra in lesion. With the patient flat on his back, the parallel, shearing forces of the air line pressure plus the counter adjustive force maintained against the vertebra below the one in lesion, break fixation. The leverage force of flexion of the unit lever handle of that portion of the dorsal column

above and including the one in lesion causes the vertebra in lesion to retrace its full arthrodial movement of flexion.

In dealing with the extension rotation type of lesion, an additional point of contact is the transverse process which is unilaterally postero-inferior. When fixation is broken this added point of contact acts as a driving force against the posterior transverse process with the result that not only is fixation broken and restoration of arthrodial movement of flexion assured but also, because of the third point of contact, the removal of the rotation side-bending is automatically guaranteed. This method utilizes a complicity of forces, counter forces, leverage forces and culminating resultant forces.

In certain hypermobile types, adjustment should be made under resistance, by asking the patient slightly to resist the operator, and particularly hold the position of flexion when adjustment is about to be made, relaxing, however, at the moment of adjustment. The position of the patient's interlocked fingers, shifted at different points behind the cervical column, will vary the amount of flexion and focus it at the point of lesion, low down when dealing with the upper dorsal column, and higher up when dealing with the lower dorsal column. This method is effective from the second dorsal to and including the first and second lumbar.

Technique No. 2. The following method is particularly applicable to the flexion type of lesion and with certain modifications is of great value for the flexion side-bending rotation variety. The patient's arms are folded across the chest in a more or less interlocked position although they do not come in contact with the chest wall. If a flexion lesion, the hand is so doubled up as to bring bilateral points of contact against the transverse processes of the vertebra below the one in lesion. The position of the hand is such that the thenar eminence is against the transverse process of the vertebra on one side and the second phalanx of the thumb against the op-

Position for adjustment of a thoracic verebra immobilized in extension. A and B indicate points of the elbows against which force is directed. C indicates direction of resultant force passing antero-posteriorly through the vertebra in lesion. D indicates direction of counter force maintained against vertebra below the one in lesion. E indicates direction of tension leverage force of flexion.

posite transverse process, spanning the spinous process in such a fashion that it rests in the groove between these two points. The operator should then immobilize the tips of the elbows of the patient by locking one in the apex of the axilla and in cupping the other in the palm of the hand so that he can utilize them as lever handles. The patient is then rolled over with the operator's hand underneath, maintaining firm counter adjustive force against the vertebra in lesion. Pressure is brought to bear upon the points of the elbows in an obliquely downward direction so that the resultant force will pass through the body of the vertebra in lesion from an antero-inferior through a postero-superior point anterior to the nucleus pulposus, which is the axis of motion of the vertebra in lesion.

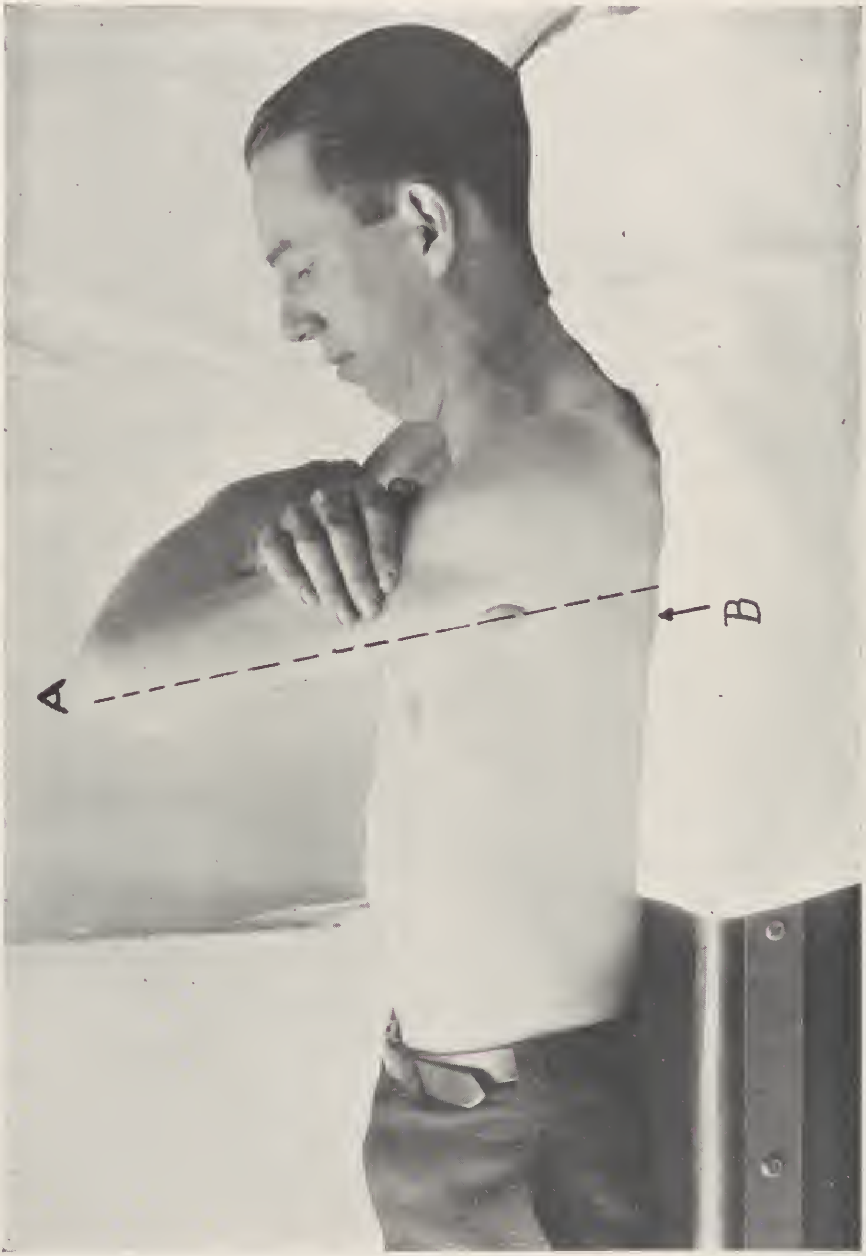
With the patient flat on his back, by means of the oblique, although parallel shearing forces, the counter adjustive force, and the above mentioned resultant force, together with the muscular leverage force incidentally evoked; fixation is broken and full restoration of arthrodial movement of extension is assured.

In dealing with the flexion, side-bending rotation type of lesion, a third point of contact is the transverse process which is unilaterally postero-inferior. When fixation is broken this added point of contact acts as a driving force against the posterior transverse process, automatically causing a reversal of the side-bending rotation. When adjusting the upper dorsal the arms approach a right angle with the body plane. The lower in the column, the greater the obliquity of the position of the arms. They approach an acute angle in the very lower dorsal---so much so, in fact, that the arms are practically in contact with the chest wall, so that a certain amount of the breaking of fixation is the result of the ventral force brought against the point of the elbows and thereby indirectly transferred to the long axis of the ribs articulating with the vertebra in lesion. This force is additional to the resultant force passing obliquely through the body of the vertebra anterior to

its axis of movement. Occasionally, in certain types of spines, the scapulae will interfere with the operator in that they come in contact with the table and therefore destroy the effectiveness of the counter force. Moreover, they may be physical obstacles to the proper placement of the hands for the maintaining of this counter force. Under such circumstances bring the points of the elbows together in the midlines so that each hand of the patient is in contact with the opposite shoulder. Immobilize the points of the elbows firmly and apply equal force upon the combined objective.

Technique for the Adjustment of the Extension Type of Lesion: In addition to the method previously described there are other methods by which adjustment of the extension lesion can be made, although the preferable technique from the point of specificity is the one heretofore given. The extension lesion cannot be corrected by direct action technique, but rather by indirect methods, usually utilizing strong flexion in such a manner as to bring the greatest degree of flexion tension upon the vertebra or vertebrae in lesion. If the lesion is secondary to flexion lesions elsewhere, it is then necessary to correct the primary lesions also, and it is better to do this previous to the adjustment of the secondary lesion. A thrust should never be given directly to the lesion but may be used advantageously at times, above and below the involved articulation. In group lesions with weak musculature, physiological and corrective exercises should be given under resistance. A very good exercise is the hugging exercise, in which the patient grasps his own shoulder blades firmly and concomitantly with deep inspiration attempts to bring his shoulder blades forward and medialward. The posture of the patient should receive due attention.

The vertex pressure movement described by Ashmore may be used for the upper dorsal. Modifications of this technique may be used as long as the principles of adjustment



Position of patient and direction of forces necessary for breaking of fixation and restoration of arthrodial movement of extension. A indicates direction of resultant force and B that of counterforce by bilateral fixation of the transverse processes of the vertebra below the one in lesion. Antero-posterior, parallel, shearing forces break fixation and oblique force through the long axis of the arms and shoulders determines arthrodial movement of extension.

are correctly applied. The operator should remember to carry out a degree of flexion which brings the greatest stress upon the articulation in lesion and cause the direction of this approximation force to pass through the body of the vertebra in lesion, anterior to the nucleus pulposus of the intervertebral disc.

The following method is very valuable. Its one fault is that it is hard to confine it absolutely and focalize it to the point of lesion. To keep it out of the realm of a general method and to confine it to a very definite, specific maneuver demands considerable care in execution.

With the patient sitting or standing back to the operator, with the hands clasped over the posterior portion of the cervical column, the operator passes his arms under the patient's axillae and allows his hands to rest over those of the patient. The operator maintains a point of contact with the chest against the vertebra below the one in lesion. The greatest degree of flexion tension is upon the vertebra in lesion. At the end of expiration the operator lifts the patient slightly, bringing about a slight amount of traction. This is accomplished by directing a slight uplift against the vertebra below the one in lesion with the chest wall, and by a slight raising of the arms which are tightly pressed against the axillae. With the patient in this position of slight traction, a sudden, forceful flexion of the head is given with the hands. This flexion is gauged so as to bring the greatest tension upon the vertebra in lesion. The "snap of the whip" effect of the posterior longitudinal ligaments is sufficient to force the vertebra into flexion.

Another method of value with the patient sitting or standing, back to the operator, is for the operator to instruct the former to clasp his hands behind his neck. The operator then places his arms underneath the patient's axillae so that the forearms cross the anterior chest wall of the patient, with the hands grasping firmly his opposite arm close to the shoul-

der. The operator maintains a point of contact with the chest against the vertebra below the one in lesion. The greatest degree of flexion tension is directed against the vertebra in lesion. The operator then enforces a slight amount of traction, exaggerates the leverage force of flexion and at the same time brings pressure against the anterior aspect (sternal ends) of the ribs articulating with the vertebra in lesion. This latter force must be distributed antero-posteriorly through the vertebra in lesion. The culmination of such counter force, leverage force, and resultant force carried out simultaneously results in adjustment.

A method for adjustment of lesions of the lower dorsal area with the patient sitting is as follows:

Flexion is carried out until the vertebra in lesion is under the greatest amount of tension. Adjustment is made with downward, backward approximation of pressure so that the direction of force is transmitted through the body of the vertebra and intervertebral disc anterior to the nucleus pulposus. A firm counter pressure is maintained against the vertebra next below with the chest.

In the group extension lesion of the dorsal area, for example the straight spine, considerable benefit may be derived from Forbes' method of placing the patient on his side and making diagonal transverse pressure upon the lateral aspects of the ribs, concomitant with deep inspiration upon the part of the patient.

Methods for Adjustment of the Flexion Type of Lesion: One method has been previously described for adjustment of the flexion lesion. This lesion can be corrected by direct action technique. A thrust can be given directly to the lesion providing the character and the direction of this force is exact. It can best be applied bilaterally to the transverse processes of the vertebra in lesion and should be directed inferiorly and forward at an angle of about one hundred and forty degrees to the planes

of the articulation. Preparatory anatomical locking of extension should be made and adjustment followed out with the patient in this position. The adjustment is best made with the patient prone. It may be accomplished with the patient sitting; and indirectly with the patient supine.

With the patient prone and maintained in a considerable degree of extension localized particularly to the area of lesion, deep sustained pressure is of great benefit, as it subjects the anterior longitudinal ligament to considerable tension, and this stretching of this ligament results in a better stabilization of the adjustment. It also has a very beneficial effect upon the intervertebral disc by putting its fibers on tension and thus counteracting the effect of the sustained compression to which it has previously been subjected by the nature of the lesion. This can best be accomplished with the Taplin table, using the mobilizer.

Method of Adjustment of the Rotation Lesion with the Patient on His Side: This form of technique can be utilized particularly in bedside work. The objective is the transverse process which is postero-inferior. The instrumentality of force is the pisiform bone. The patient lies on his side, with the posterior transverse process uppermost. The forearm is flexed, with the point of the elbow resting against the groin. The shoulder girdle is manually immobilized by the hands of the operator and the pisiform bone is brought into contact with the objective. Traction, and extension of that area of the spine in which adjustment is to be made is brought about by upward pressure exerted against the elbow and the bi-manual immobilization of the shoulder girdle in a backward position. At the summit of this combined tension, adjustment is made by bringing sudden force against the transverse process which is downward and backward, carrying it upward and forward.

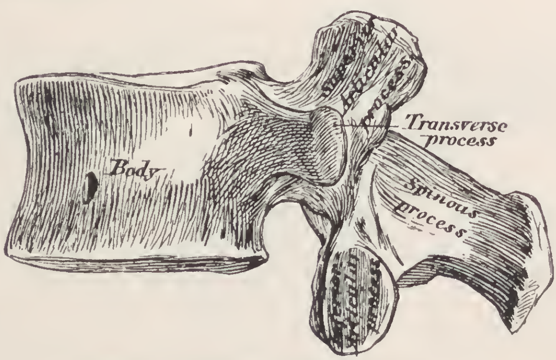
Method of Adjustment of the Rotation Lesion with the Patient Standing: With the patient standing, back to the operator, adjustment of the lower dorsal vertebra is possible by using the index or middle finger of the patient as the instrumentality of adjustive force, and by placing these fingers against the objective, or in other words, the transverse process which has rotated postero-inferiorly. The operator steps close to the patient, facing the patient's back. With his chest firmly held against the patient's hand, particularly the two fingers composing the instrumentality of adjustive force, he clasps the body of the patient, with the hands folded across the latter's chest so as to hold his body firmly against him. Maintaining a firm fixation against the chest of the patient, he brings added pressure with the chest against the patient's hand in an upward direction. The traction extension incidentally produced is sufficient to insure locking and counter resistance to effect the adjustment. This form of adjustment is only applicable to the very lower dorsal vertebra.

CHAPTER VIII.

SUBLUXATIONS OF THE LUMBAR VERTEBRA

Applied Anatomy: The **lumbar vertebrae** are the largest movable segments of the vertebral column and can be readily determined by the absence of foramina in their transverse processes, the distinguishing mark in the cervical vertebrae, and by the fact that there are no costal facets on the sides of their bodies, the characteristic distinction of the thoracic vertebrae.

The bodies of these vertebrae are large, wider transversely than antero-posteriorly, and are slightly thicker in front than behind. Lumbar spinous processes are thick, broad, quadrilateral in shape, and they project horizontally backward. The superior articular processes project upward and their facets are concave and face backward and medialward. The inferior articular processes project downward and their facets are convex, facing forward and lateralward. The former are wider apart than the latter and embrace the lower articular processes of the vertebra next above. The pedicles are directed backward from the upper part of the bodies of the vertebrae and consequently the inferior intervertebral notches are of greater proportionate depth. The laminae are broad, short, and strong. The vertebral foramen is intermediate in size to the thoracic and cervical region and triangular in shape.

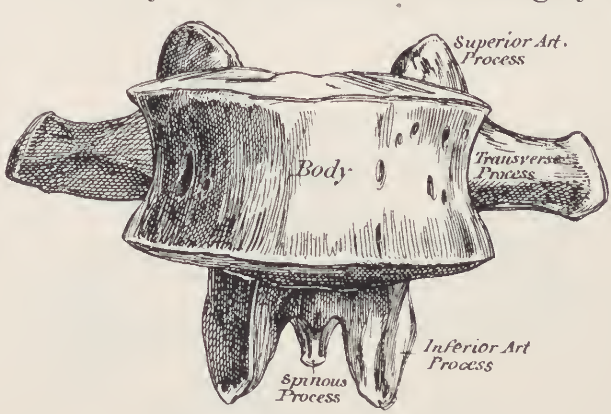


Lumbar vertebra, lateral view.

The transverse processes are long and slender; they are directed horizontally and lateralward in the upper three lumbar vertebrae and tilt slightly upward in the lower two. They are situated just in front of the articular processes and are homologous to the ribs. Three tubercles are noted in connection with the transverse processes of the twelfth thoracic and lumbar vertebra; a superior, called the mammillary process, an inferior, the accessory process, and an external or costal process. The first two are rudimentary but true transverse processes and the third is the homologue of the rib. The twelfth thoracic vertebra is classified with the lumbars for purposes of convenience and because of the fact that its inferior articular facets are similar to those of a typical lumbar segment.

The fifth lumbar vertebra is characterized by a body which is much deeper anteriorly than posteriorly, a smaller spinous process, and a wider interval between the inferior articular processes. The transverse processes are larger and thicker than those of the other lumbar vertebrae.

The lumbo-sacral articulation is mechanically weak. The size and shape of the transverse processes are asymmetrical in a large majority of cases. Human nature seems to be in an incomplete evolutionary stage between quadrupedism and bipedism. The key to the situation lies largely within the



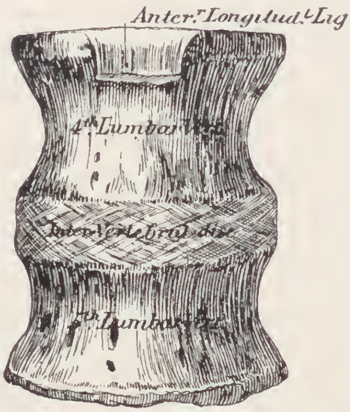
Lumbar vertebra, anterior view.

lumbar curve, for upon the nature and character of changes appearing at this point depends the proportionate advancement in the evolutionary change to the upright position. Therefore if the lumbar curve is subject to lumbo-sacral variations, whether accidental, incidental, or evolutional, the fifth lumbar vertebra must bear a large share of the burden.

Anatomical variations of the lumbo-sacral region are quite demonstrable in the living if one is willing to accept roentgenogram studies as proof of their presence. The lumbo-sacral and the ilio-femoral articulations are freely mobile if compared with the sacro-iliac joint. Compensation, therefore, will always seek the point of least resistance to establish counter balance or readjustment, and therefore the lumbo-sacral articulation compensates for many pelvic asymmetries.

The normal lumbar curve is convex anteriorly, the convexity being greatest at the sacro-vertebral angle. The thoracic and pelvic curves are the primary curves formed at an early period of fetal life and are due to the shapes of the bodies of the vertebra. The cervical and lumbar curves are compensatory or secondary and are developed after birth to secure and maintain the upright position. They are due primarily to the shape of the intervertebral discs together with the influence of heavy muscles of the back which are powerful factors in holding the spinal column erect. When they contract they steady the lower part of the spine, and also create more lumbar curve; in fact they act as powerful levers by co-operating with their sacral fixed points to stabilize the entire spine. The line of gravity or of weight bearing passes in front of the core (nucleus pulposus) of each intervertebral disc. The pull of the muscles is behind. Some authorities state that the line of gravity passes through the center of the body of the second lumbar vertebra, others give it as the third. It is probably an intermediate point. Constant lumbo-sacral disturbance, lumbar pain of a vague chronic aching

type is typical of muscle-fatigue or strain from the effort to maintain balance. By shifting the weight-bearing center, one can do much for the relief of these symptoms, as for example, changing the heels of the shoes; by correcting the posture and by comprehensive study of the basic principles involved in imbalance, as well as the particular causative factors involved in each individual case.



Anterior view of intervertebral disc with the adjacent vertebral bodies.

The Lumbo-Sacral Articulation: The ligaments connecting the fifth lumbar vertebra to the sacrum are similar to those that connect the segments of the vertebral column to each other. The anterior and posterior common ligaments are continued downward. The ligamenta subflava connect the arch of the last lumbar vertebra with the posterior border of the base of the sacrum. The capsular ligaments connect the articular processes and allow for the formation of double arthrodia. The inter- and supra-spinous ligaments are present.

The **lumbo-sacral ligament** is a thick triangular ligament which is attached to the lower anterior portion of the transverse process of the fifth lumbar vertebra and passes obliquely outward to become attached at a lower level to the lateral surface of the base of the sacrum.

The **ilio-lumbar ligament** passes horizontally outward

from the tip of the transverse process of the fifth lumbar vertebra to the crest of the ilium, immediately in front of the sacro-iliac articulation.

The **fifth lumbar articulation** is a comparatively free amphiarthrosis, having about the same physical characteristics as those of the other vertebra, although it is not uncommon to find considerable variation in the relative positional plane of its inferior articular facets.

Flexion: The core of the intervertebral disc acts as the fulcrum in this movement. Flexion is the freest of all movements in this area and can be normally carried to a point just beyond a straightening of the lumbar curve, the movement occurring in the vertical plane of the facets. It is greatest at the apex of the lumbar curve; in other words, it increases from above downward and is greatest between the fifth lumbar and the sacrum. There is compression of the intervertebral disc in front and decompression behind. The inferior articular processes slide upward because of the buckling effect of the compression in front and decompression backward. Limitation of forward bending is determined by the degree of tension of the posterior longitudinal, interspinous and capsular ligaments. The degree of compression of the disc in front is an added factor. A certain amount of ligamentous tension is maintained at all times for the reason that the ligaments lie longitudinally to the direction of tension and radially to the direction of motion. The intervertebral foramina are enlarged during flexion.

Extreme flexion creates an anatomical locking of the lumbar spine and the lower thoracic so that little or no rotation and but slight side-bending are possible. A large percentage of side-bending rotation lesions are produced in side-bending rotation with the lumbar spine in moderate flexion. Attempted recovery to the erect position may create an articular locking of the inferior articular processes of the upper verte-

bra as they pass beyond the upper edge of the superior processes of the lower. They assume an angle and produce a consequent indentation of the lower edge of the articular facet against the articular facet and capsule of the opposing joint surface. The planes of the articular facets are not parallel, hence a resultant abnormal bony contact is produced, maintained and increased by the tension of the interspinous and other ligaments. The individual should recover from side-bending rotation before assuming the erect position. To recover from flexion at the angle imposed by side-bending

Demonstrating flexion on the Halladay spine. Locking first takes place in the upper cervical and lower lumbar and is followed by locking of the upper lumbar, lumbo-dorsal and lower cervical areas. The last to lock is the upper mid-dorsal or interscapular area.

rotation is comparable to the attempt to close a drawer at an angle. Nature has amply provided for all combinations of movements and unless there is uncoordinated or imbalanced soft tissue tension, recovery of the erect position at an angle can be accomplished with safety.

The greater the flexion in the lumbar area from above downward, the lower the locking against rotation and side-bending. The greater the flexion from below upward in the lumbar area, the higher is the locking against rotation and sidebending. A considerable degree of flexion limits side-bending rotation passively and is, therefore, of aid in adjustment. It is possible to lock the lumbar articulations, one by one, with passive movement from above downward and below upward against side-bending rotation by a gradual increase in the amount of flexion either from above downward or below upward.

An easy degree of flexion allows considerable passive movement of side-bending rotation of the body of the vertebra toward the convexity of the curve. Hyperflexion limits this possibility and in hyperflexion with attempted side-bending, rotation of the body of the vertebra is toward the concavity. The same is respectively noted in passive movement in hyper extension and easy extension, the body of the vertebra in the former rotating toward the concavity and in the latter toward the convexity, when side-bending is the primary attempted passive movement.

Extension: The core (nucleus pulposus) of the intervertebral disc acts as the fulcrum. Movement occurs in the vertical plane of the articulation. Extension is confined largely to the dorsal and the upper two lumbar vertebrae. The reason for this is an evolutionary one: the change from quadrupedism to bipedism in which an increase in the sacro-vertebral angle and resultant increase in extension of the lower lumbar has been a primary compensatory factor. All comparative estimates are made with the patient in the erect

position, hence the limitation of further extension is readily appreciated. There is compression of the disc behind, and decompression in front and the inferior articular facets slide downward and also inward due to the character and direction of the buckling. Limitation of further movement is determined by the tension of the anterior longitudinal ligament, compression of the disc, and bony contact---the inferior articular processes of each joint approximating the laminae of the vertebra below. A secondary movement of a slight degree is possible, the axis of movement shifting posteriorly to the points of contact limitation, allowing slight further decompression of the disc and stretching of ligaments anterior to this point together with slight sliding of the bony contact points. The intervertebral foramina are diminished in size.

Hyperextension restricts rotation to the dorso-lumbar area, locks the thoracic spine and limits side-bending to the lumbar area. The greater the degree of extension, the lower in the lumbar spine is the movement of side-bending. Voluntary extension side-bending is always accompanied by rotation of the bodies to the concavity, although it is limited in the extent of the rotation by the degree of extension.

Side-Bending: Side-bending is a free movement in the lumbar area. It is greatest in the erect position and least in flexion. It is limited by extension. It is always associated with rotation. Side-bending rotation is highest in flexion, is lower in the erect position, and is lowest in extension. Voluntary side-bending rotation with rotation of the bodies of the vertebrae toward the convexity demands secondary rotation and is problematical. The opposing quality of both forces would tend to lock the vertebrae at more or less of a central point with their bodies in a more or less central position. Any appreciable rotation of the body of the vertebra in primary side-bending, secondary rotation, with the body rotating toward the concavity is questionable, although its greatest possibility would be with the lumbar

Demonstrating side-bending on the Halladay spine. Note the accompanying rotation to the concavity of the curve.

spine in erect position, easy extension, or easy flexion. In passive enforced movement, primary side-bending, secondary rotation, with rotation of the body of the vertebra toward the convexity is possible; when the spine is in the erect position, easy flexion or easy extension, but not in hyperflexion or hyperextension.

Rotation: Rotation in the lumbar area is extremely limited, is diminished in hyperextension, and least in flexion. Rotation side-bending is highest in flexion, is lower in the erect position, and lowest in extension. The bodies of the vertebrae rotate toward the concavity of the curve, whether the result of voluntary movement or enforced passive movement. Rotation and hyperextension is confined to the dorsal area. The centers of rotation are in the tips of the spinous processes.

Lesions of the Lumbar Vertebra:

1. Flexion Lesion
2. Extension Lesion
3. Rotation Side-Bending Lesion } Right or Left Lateral Lumbar Lesions
4. Side-Bending Rotation Lesion }
5. Combined Lesions

The Flexion Lesion: (Bilaterally Posterior Lumbar). The flexion lesion is an immobilization of a vertebra in the position of flexion. The vertebra en masse assumes greater prominence posteriorly and, if part of a group lesion, the concavity of the lumbar curve is decreased throughout the area involved. It is commonly called a posterior lesion. The inferior articular processes of the vertebra in lesion move upward and tilt slightly backward, the facets passing beyond the upper edge of the superior of the vertebra below. The fulcrum is the core of the intervertebral disc and the movement occurs in the vertical plane of the facets, although the arc of motion is up-

ward and forward, the buckling is backward, consequently the lesion is posterior.

Etiology: Functional and postural abuse is the usual cause of the group lesion. It may be secondary to bilaterally anterior innominates and the posterior sacrum (base rotated backward, which in reality is an extension movement). It is often the forerunner of the straight spine and may be associated with atonicity of the lumbar extensors from a debilitated or toxic state. The individual lesion may be due to reciprocal innervation, trauma, such as falls, wrenches or strains resulting from heavy lifting and extremes of forced flexion with ligamentous strain and injury. It is sometimes found as a secondary or counterbalancing lesion.

Diagnosis: The vertebra is en masse posterior because of the backward buckling of the spine at this segment due to the compression in front and decompression behind the axis of motion. There is approximation of the spinous process of the vertebra in lesion with that of the one above and separation from that of the vertebra below. The spinous process of the vertebra in lesion is also relatively more prominent posteriorly; especially when the patient is in extension, as this exaggerates the lesion. Moderate flexion, although it throws all the vertebrae into greater relief posteriorly, tends to diminish apparently the amount of structural perversion of the lesioned segment. Motion is restricted where there is separation; in other words, between the vertebra in lesion and the one below. Motion is free where there is approximation, or between the vertebra in lesion and the one above. Neither flexion nor extension can change the amount of separation between the spinous process of the vertebra in lesion and that of the one below. The inferior margins of the inferior articular processes assume greater prominence posteriorly. It must be kept in mind that

the fourth lumbar vertebra has normally a long spinous process and the fifth a short one, otherwise mistaken deductions may ensue.

Differential Diagnosis: Confusion may exist at times as to whether the lesion is a flexion lesion of a particular vertebra or an extension of the one above. A safe rule to apply is---restricted motion where there is separation indicates a flexion lesion; moreover, the fact that extension will produce no apparent approximation proves definitely the presence of a flexion lesion. Still more conclusive proof is the fact that there is free movement where there is approximation. In this particular instance, it would characterize the vertebra above the one in lesion. The reverse of the above would indicate an extension lesion.

Treatment: **Technique No. 1.** Using direct action technique the objective is either the inferior articular process or the spinous process and the applied force is directed inferiorly and downward with the patient prone. Place pillows under the thighs to bring patient into primary position of extension. Complete adjustment with bilateral application of the thrust against the inferior articular processes of the vertebra in lesion, or against the spinous process, in the latter case being careful to direct the force inferiorly as well as downward. An additional measure of great value is the application of deep mobilization on the Taplin table. With the patient prone, using the mobilizer, ligamentous and muscular structures anterior to the axis of motion may be subjected to strong, deep alternate stretching and relaxation which leaves the anterior common ligament, psoas major muscle and other associated soft tissues in better physiological repose and less subject to imbalance which may predispose to a recurrence of the lesion. It is merely an added factor in the stabilization of adjustment.

Technique No. 2. With the patient sitting, operator stands directly behind. Have patient fold the arms. The

objective should be the upper posterior aspect of the spinous process. The operator should use the hypothenar eminence as the instrumentality of adjustment. The applied force should be directed inferiorly and forward, and concomitantly with bringing the patient back into extension.

Unilateral methods of adjustment of this particular type of subluxation will be discussed in detail under the treatment outlined for the lateral lumbar lesions.

The Extension Lesion: (Bilaterally Anterior Lumbar). The extension lesion is an immobilization of a vertebra in the position of extension. The vertebra en masse assumes greater prominence anteriorly and, if a group lesion exists the concavity of the lumbar curve is increased. It is commonly called an anterior lesion. The inferior articular processes of the vertebra in lesion move downward and tilt slightly inward or forward. The superior articular processes move downward and backward, assuming greater prominence posteriorly. The spinous process is relatively more oblique. The fulcrum is the core of the intervertebral disc and the movement occurs in the vertical plane of the facets.

Etiology: Functional and postural abuse is a less common cause of this condition than when associated with the flexion group lesion. When found under these conditions it is usually secondary to such abnormalities as pot belly, flat feet, high heels, etc. It may be counter balancing for bilaterally posterior innominates or flexion of the sacrum, in which case it is the forerunner of the type of spine in which the normal curves are accentuated.

Diagnosis: The vertebra is en masse anterior because of the forward yielding of the spine at that point due to the compression behind and the decompression in front. There is approximation of the spinous process

of the vertebra in lesion with that of the one below and separation from that of the vertebra above. The spinous process is relatively more oblique and less prominent posteriorly and this is particularly noticeable with the patient in the position of flexion, as the lesion is thereby exaggerated. The lesion is less noticeable with the patient in extension as the amount of structural perversion is thereby apparently lessened by the position of the adjacent vertebra. Motion is restricted where there is approximation or between the vertebra in lesion and the one below and is free where there is separation or between the vertebra in lesion and the one above. Flexion and extension cannot change the amount of approximation between the spinous process of the vertebra in lesion and the one below. The superior articular processes assume greater prominence posteriorly. The concavity of the lumbar curve is increased in the group lesion.

Treatment: **Technique No. 1.** Using indirect action technique with the patient supine and the objective the superior articular processes of the vertebra in lesion, the operator flexes the knees on the thighs and the thighs on the abdomen. Bilateral fixation of the superior articular processes is maintained with one hand and with further flexion of the legs and thighs the operator then with exaggeration of the pressure against the superior articular processes completes the adjustment with quick, forcible downward, forward pressure against the patient's knees, in such manner that the resultant force passes through an imaginary point in the lower portion of the sternum. Leverage and resultant forces are opposed by counter adjustive force and the sum total of these forces is sufficient to effect the adjustment of this lesion.

Technique No. 2. Using direct action technique with the patient prone and if possible in easy flexion. The thrust should be delivered bilaterally against the superior articular processes of the vertebra in lesion, being careful to direct force superiorly as well as downward.

Technique No. 3. Patient is seated on the stool in a position of moderate flexion. Operator rests pectoral area on the shoulder of the patient, and upper arm of the same side on his opposite shoulder. Operator should grasp the stool firmly with the hand of the same side and attempt strong approximation. He should graduate flexion to the angle necessary to bring the greatest leverage on the vertebral articulation in lesion.

Unilateral methods of adjustment of this particular type of subluxation will be discussed in detail under the treatment outlined for lateral lumbar lesions.

The Side-Bending Rotation Lesion: Nomenclature for this lesion is not based on whether side-bending or rotation is the primary attempted move, but rather upon the respective amounts of movement entailed---for instance, rotation might be the primary attempted movement, but because of the greater predominance of secondary side-bending, it is better to consider them as merely variations of side-bending rotation. Rotation normally is negligible in comparison with side-bending, although there are really two kinds of lateral lumbar lesions.

(a) The type of subluxation which occurs in primary side-bending, and more often in flexion.

(b) A traumatic lesion, a type in which rotation is primary and side-bending secondary. There is more torsion in the traumatic lesion, and therefore a greater percentage of rotation.

A definite distinction cannot be clearly made for the reason that there may be such varied proportions of side-bending and rotation. The nearer the lesion approaches the mechanical possibilities of the lumbar spine, the greater is the percentage of side-bending and the more it is typically a subluxation of primary side-bending.

This type of lesion is commonly involved with flexion in contradistinction to the traumatic lesion which may as readily occur in extension as in flexion. A lateral lumbar lesion involving extension would, therefore, be more or less traumatic in character and indicate a primary rotation. These lesions are commonly called right or left lateral subluxations and are, inversely speaking, side-bending lesions to the right or left. If a group lesion, a functional lateral curve will ensue. The bodies of the vertebrae rotate to the concavity in such cases. The axis of movement of side-bending is through the intervertebral core and point of limitation, but further combined with rotation, the axis of movement becomes a line drawn through the intervertebral core, and the articulation of the convex side.

Etiology: Functional or postural abuse may be the cause of the group lesion. The individual lesion is often the result of strain produced with the patient in a position of flexion and side-bending. Occasionally the lesion is produced during the return to the upright posture, particularly when lifting some heavy object. Reciprocal innervation is a common cause, as is also trauma, the former tending to produce the typical type of subluxation, and the latter the traumatic. Efforts to save oneself from falling and lifting heavy objects above the head are examples of the type of torsion productive of the traumatic lesion.

Diagnosis: Primary diagnosis can best be made with the patient in the position of easy flexion, as this throws the vertebrae into greater relief posteriorly. The muscular mass over the transverse processes of the vertebra in lesion will be thickened and contractured, and sensitiveness will be marked. If the operator possesses an extraordinary amount of palpatory skill he may be able to make a more or less accurate positional diagnosis, although because of their depth in the muscle-mass and irregularity, no accurate or positive diagnosis can be made with any great de-

gree of certainty. The lateral deviation en masse of the spinous process of the vertebra in lesion is the primary diagnostic factor. The spinous processes of the lumbar vertebra are fairly accurate indicators as to the position of the vertebra, as they are not usually subject to anatomical deviation. In other words, they are morphologically constant, in contradistinction to the spinous processes of the vertebrae above. There are, of course, exceptions to this rule.

In lateral flexion, the lower border of the spinous process of the vertebra in lesion will be relatively more palpable on the side of the convexity, and the upper border is usually relatively more prominent on the side of the concavity. The amount of rotation can be determined by comparison of the lateral borders of the vertebra in lesion. The greater the rotation, the less prominent the lateral border of the spinous process on the side of the convexity and the more prominent the lateral border on the side of the concavity. This is due to the greater deviation from the median line. In side-bending the vertical plane of the spinous process bisects a line dividing the spinous processes longitudinally. Normally these lines should be indentical. If flexion or extension are complicated with a lateral deflection it is suggestive as to the type of subluxation. It should be kept in mind that in the lumbar area the spinous processes are in a horizontal plane with the articulations of the vertebra. Restriction of motion is found between the vertebra lesion and the one below. Exaggeration of the lesion by side-bending rotation of the vertebrae in that area toward the convex side, in other words, toward the side to which the spinous process is deflected, immediately magnifies the relative amount of structural perversion. Side-bending rotation toward the concave side will cause the lesion practically to efface itself as far as apparent physical malalignment is concerned.

It must be borne in mind that in the lumbar area the spinous processes are in approximately a horizontal plane

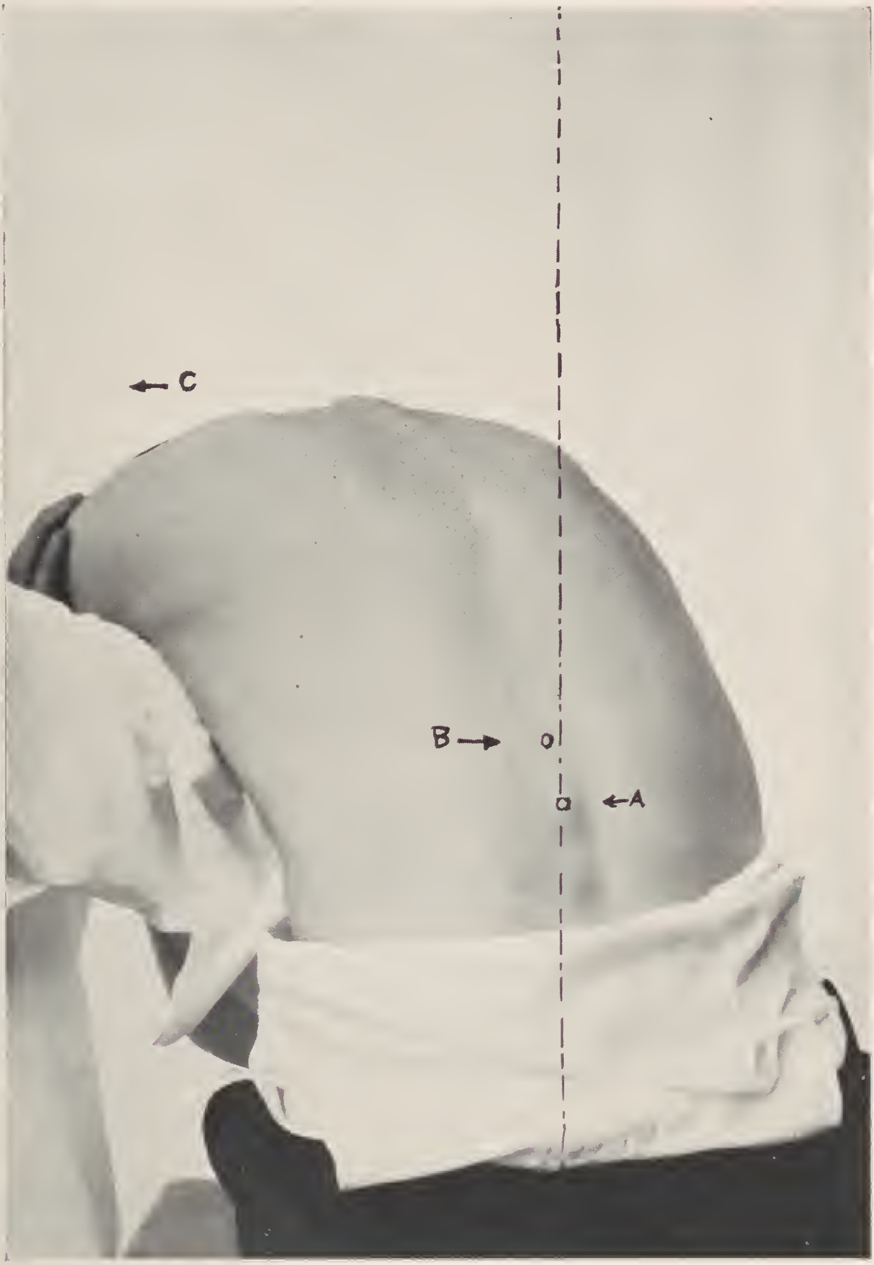
with the articulations of the vertebrae to which they are attached. Sensitiveness can usually be elicited over the transverse processes and on the concave side of the spinous process of the vertebra in lesion. The subjective symptomatology varies greatly.

Treatment: The general principles of adjustment proper are as follows:

(1) Side-bending to the side of the convexity.
(2) Adjustment with rotation toward the side of the convexity.

Technique No. 1. With the patient sitting the lesion may be adjusted in varying degrees of flexion by increasing forward bending from above downward in such a way as to bring the apex of flexion at the point of lesion. The objective in this case is the lateral aspect of the spinous process on the convex side. Side-bending should be utilized in such a manner as to bring the patient slightly out of balance with the trochanter slightly off the table so that the patient is reflexly unable to contract at the moment of adjustment. The patient can be maintained in such a position only a short time before he automatically attempts counterbalancing, therefore, adjustment must immediately follow side-bending toward the convexity and off balance. The adjustive force is rotatory in character toward the convex side.

Technique No. 2. A very good method of adjustment with the patient sitting is accomplished as follows: Hook the fingers in front and against the anterior superior spine of the innominate on the concave side and curve the thumb of the same hand firmly around the spinous process so that pressure is brought to bear on the lateral aspect of the convex side of process. After obtaining this hold, side-bend and rotate toward the convex side, at the same time maintaining firm fixation of the innominate and firm pressure against the spinous process. This procedure may be used on the three lower lumbar vertebrae.



Position for adjustment of rotation side-bending lesion of the twelfth dorsal vertebra unilaterally posterior on the right, anterior on the left. Anatomical tension locking by forced flexion down to and including the vertebra in lesion comprises lever handle which carried in the direction pointed out by arrow C constitutes leverage force. Arrow B indicates direction of transverse corrective force against convex side of spinous process of vertebra in lesion. Arrow A points out pseudo-flexion lesion.

Technique No. 3. With the patient prone, adjustment can be made by bilateral pisiform contact and a superimposed trust. The pisiform bone of one hand must be placed against the transverse and superior articular process of the vertebra below the one in lesion on the convex side. Adjustive force must be carried downward and slightly toward the head. The opposite pisiform bone should be in contact with the transverse process and superior articular process of the vertebra in lesion on the concave side, and adjustive force should be carried downward and slightly toward the foot, and both forces delivered simultaneously.

Technique No. 4. The best and easiest method of adjusting side-bending rotation lesions is with the patient on the side as follows: Consider the hypothetical lesion a right lateral third lumbar. The patient should lie on the concave side, or in other words with the convex side up. Therefore the patient lies on the left side. Side-bending to the convexity ensues as the result of the fact that there are only two points of contact, the pelvis and the shoulder girdle, and the intermediate portion is in suspension. Thus the unsupported area, the lumbar region, must naturally assume a lateral flexion between the above supports. The lumbar spine should then be anatomically locked in flexion from below upward as far as the articulation in lesion. The exact degree of flexion can be determined by placing the tip of the finger between the spinous process of the vertebra in lesion and that of the one below and follow with flexion until the force of flexion is sufficient to bring a slight separational strain and tension of tissue between those points. Do not carry beyond that point. The thoracic and lumbar spine above the vertebra in lesion should be maintained in a stabilization locking by a combination of extension and reverse rotation. This extension and reverse rotation should carry down as far as the articulation in lesion. The anatomically locked lumbar spine is the lever handle through which the adjustment is completed. The stabilization locking is for the purpose of paralleling the

planes of articulation and maintaining counter resistance to the adjustive force. Rotation of the lower segment toward the concavity is better than any attempted rotation of the upper segment toward the convexity, principally because there is no effective lever handle through which the latter can be accomplished. The stabilization locking should not be used for that purpose. The adjustive force through the locking lumbar lever control should be directed forward and upward so that the adjustive force is applied in a plane parallel to the planes of the articulation and thus arthrodial movement throughout a proper range is restored. To correct lumbar lesions with this method, the higher in the lumbar area the lesion, the greater is the flexion from below upward and the shorter the extension and reverse rotation from above downward. Lengthen the extension from above downward and shorten the flexion from below upward for lesions lower down in the region. Proper graduation of the above locking forces is absolutely essential if adjustment and not indiscriminate popping is expected. This method of adjustment is effective for all vertebral lesions in the lumbar area and may also be used occasionally in the dorso-lumbar and lower thoracic areas. It is not advisable to attempt adjustment with it above the tenth dorsal. It is not necessary to bring digital pressure upon the spinous process of the vertebra in lesion as an aid to adjustment. A finger may be placed directly over the articulation in lesion to be sure that locking forces fall above and below and not upon that articulation as it must be left unprotected.

The above technique used bilaterally instead of unilaterally is an effective maneuver for the adjustment of the bilateral lesion in an inverse manner, for as the articular facets of one side describe the unilateral movement of flexion, those on the opposite side describe the unilateral movement of extension. Carried out on both sides or bilaterally it is therefore effective for either the flexion or the extension lesion as

Position of patient for adjustment of a second lumbar vertebra immobilized in side-bending rotation to the right (left lateral second lumbar). Primary movement of side-bending to the convexity is indicated by the lines A and B. B also indicates lower lever handle, unification of which is assured by anatomical tension locking of flexion. A indicates upper lever handle obtained by stabilization locking in reverse rotation. Arrow D points out convex side of spinous process. Arrow E indicates direction of corrective force using lower lever handle.

both facets have unilaterally described the full range of unilateral flexion and extension.

The rotation side-bending lesion, as has been mentioned previously, is of traumatic origin, and a greater percentage of rotation is found than is customary. There is usually greater deviation of the spinous process from the median line than is found in the side-bending rotation lesion. However, rotation at its best is more or less of a negligible factor; therefore, clinically, it is not necessary to place particular emphasis upon this lesion. The same methods of adjustment would be used as in the correction of the side-bending rotation lesion.

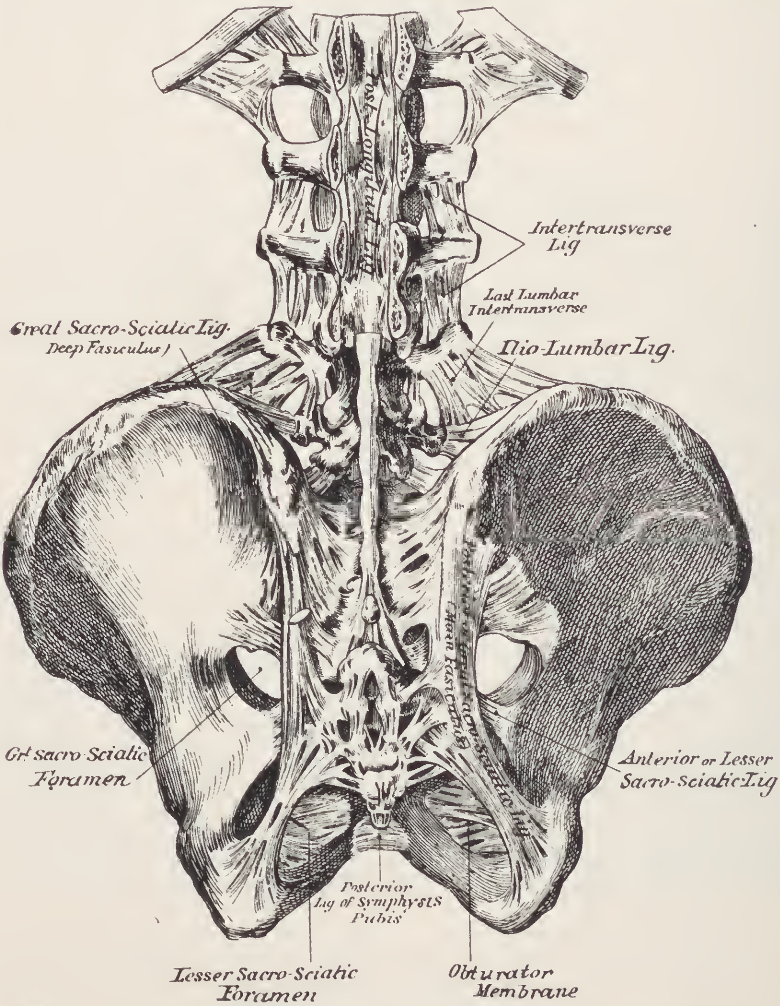
The combined lesions are: first, side-bending rotation complicated with flexion or extension; and, second, rotation side-bending lesion complicated with extension or flexion. Adjustment of these lesions necessitates the removal of the side-bending rotation or the rotation side-bending as the factor of prime maintenance of the lesioned condition. If the secondary factor of flexion or extension does not spontaneously adjust itself, additional adjustive effort should be utilized.

Stubborn or rebellious pain which defies all adjustive measures should be carefully handled and the physician should rule out by the x-ray or allied means such conditions as sacralization of the fifth lumbar which is due to a broadening of the body of the fifth and partial fusion with the sacrum, arthritis due to over-strain of the lumbo-sacral articulation which demands that the spine be kept erect and supported to lessen irritation, spondylosis, with its history of specific infection, primary spondylitis deformans without any particular history, as well as deformities of the fifth lumbar, and other structural and pathological involvements of the lumbar vertebrae.

CHAPTER IX.

SUBLUXATIONS OF THE SACRO-ILIAC ARTICULATIONS.

The **sacro-iliac joint** is an amphiarthrosis. It is incompletely covered with hyaline cartilage and has a rudimentary synovial membrane. The articulating surfaces are composed of two definite zones, a central or articulating, (which is smooth but wave-like), and a peripheral, (which is rough for



Posterior view of the articulations of the pelvis.

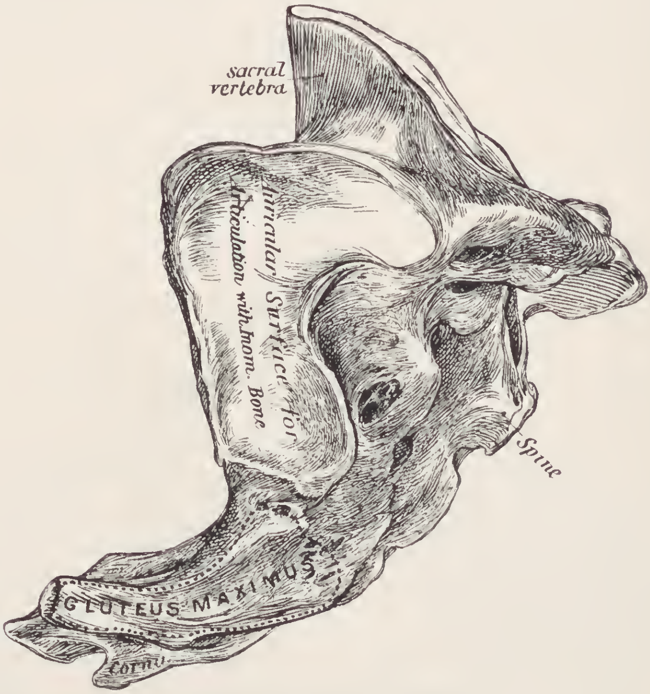
fibrous tissue attachments). Occasional bands of fibrous tissue pass directly across the capillary space of the peripheral zone of the joint from one surface to the other. The two zones are not concentric and the articular surfaces themselves, irregular and roughened, present marked concavities or convexities which receive corresponding convexities or concavities from the opposing surfaces. These opposing surfaces are nearly of the same size, thereby limiting joint action greatly. The capsular ligament of the articulation is made up largely of the periosteal membranes of the two articulating bones.

Structurally the sacrum is positionally placed between the two ilia so as to present the characteristics of a double keystone which is both wider in front than behind and above than below. The arrangement is such that the apex of one wedge is downward and backward (the anatomical apex of the sacrum) and that of the other is directed upward and backward (a cross diameter drawn through the dorsal aspect of the bone between its second and third segments).

Inasmuch as the sacro-iliac articulation presents the characteristics of an inverted wedge and its articular surfaces are too vertically disposed to allow it to serve as a weight-bearing mechanism, this particular function falls upon the posterior sacro-iliac ligaments which act in such manner as to hold the sacrum between the innominates in suspension. Moreover, they act as the axis for rotation in the joint, which movement is more likely to be about a traveling center than about a fixed point.

The **sacrum** is the base of the spine and the sacro-iliac joints are always the bases of the two ilia. The ilia start from the sacro-iliac joints at their bases and proceed on a curved course until they converge at the pubes. They are powerful and rigid levers and have much to do with the stability and instability of their basal joints. For example, if the left rectus abdominis and the right gracilis and adductor muscles contract violently at the same time, the pubes may

be pulled out of symmetry, left side up and right side down, which means that the ilia have created motion in one or both sacro-iliac joints commensurate with that exhibited at the pubes. These powerful levers are accurate indicators as to the type and degree of dislocation or subluxation, inasmuch as they magnify at the pubes very slight malpositions at their bases. They moreover suggest themselves as more or less effective lever handles for adjustment.



Lateral view of the sacrum.

The weight of the body is transmitted through the pelvic girdle in a zigzag manner. It is received first centrally, upon the antero-superior surface of the sacrum. It is then directed backward, and lateralward to the posterior sacro-iliac (suspensory) ligaments. From this point it is transmitted antero-laterally to the heads of the femora. This transmission must accommodate itself to many shifts of position in the dynamic individual for the acts of walking or running necessitate rapid changes in weight bearing. Hence, the

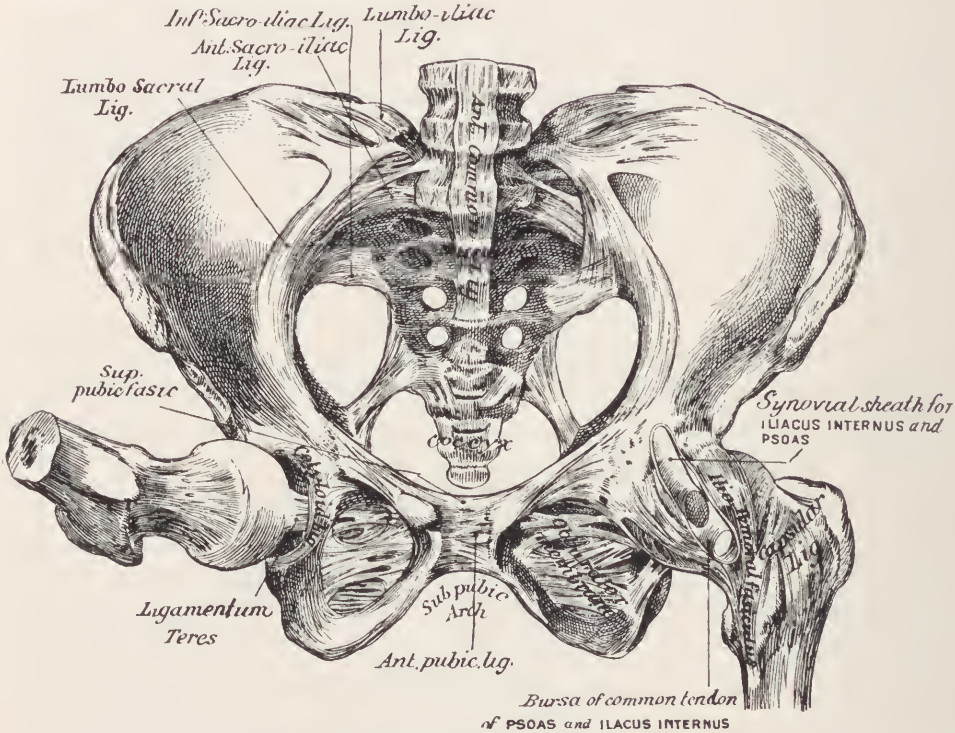
irregularity and frequent shift of weight transmission requires a necessary structural stability of the sacro-iliac articulations.

When heavy burdens are superimposed upon the spine, the sacral wedge tends to descend between the ilia, thus permitting the pelvic girdle to tighten up to its anatomic limit. The sacro-iliac joints are too nearly vertical to be regarded as weight-bearing areas. In fact they never bear weight unless the individual lies on his side, in which case they are subject to lateral compression. The sacro-iliac ligaments are the weight-bearing mechanisms of the joint.

The horizontal axis is still retained in the change from quadrupedism to bipedism although a greater functional demand is made upon the lumbar curve in the latter instance. The forward end of the spine loses none of its original support, but the added weight of the forelegs falls upon the sacro-iliac joint. All strains received from above downward must be computed through the torus of the lumbar curve. The weight-bearing sacrum serves to tighten the pelvic girdle, inasmuch as the bone tends to be driven backward between the innominates, principally because a mechanical estimate of such superincumbent weight must take into consideration its backward deflected distribution through the lumbar curve. The added tendency to a downward tilting of the base of the sacrum is prevented by a tautening of the sacro-sciatic ligaments plus a tightening of the wedge from below upward posterior to the axis of motion as a result of the apparent rotary inclination of the sacrum. The axis of this rotation passes transversely through the sacro-iliac ligaments inasmuch as they serve as a fulcrum for such movements.

The double wedge shape of the sacrum and the manner in which these two wedges are tightened by the position of the weight on the sacrum is highly significant in that it indicates that most innominate lesions occur or tend to occur with the individual recumbent; or, in other words, when the superin-

cumbent weight does not affect the joints. Under such circumstances severe trauma can most easily produce lesioning of the sacro-iliac joints.

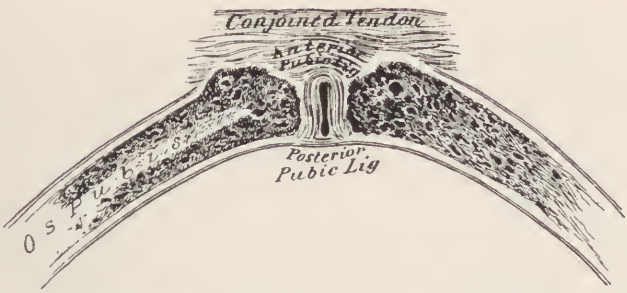


Anterior view of the articulations of the pelvis and hip.

When an individual is standing the lumbar spine assumes its characteristic curve and the sacrum retains its horizontal axis. However, when the patient is sitting, the axis of the sacrum is almost vertical. The same is true when a quadruped stands erect on its hind legs. Indeed a postural remedy for a patient suffering from lumbo-sacral pain is suggested by this knowledge of shifting axes. Normal standing posture should be such that the anterior superior spine and the symphysis pubis are in a perpendicular plane parallel to the line of gravity of the body.

The sacro-iliac joint is not constructed for particular, definite physiological movement, for the muscles of the pelvic

girdle do not possess a direct or discernable connection with powerful movement of the bones, one upon another. It does, however, allow a slight yielding motion which is both arthrodial and rotary in character. Nature endowed us with a rigid and stable support; but she was also careful not to make this support too rigid; otherwise she would have defeated one of her great purposes. In other words: she fulfilled the functional demand for elasticity by providing this sufficiently yielding structure to withstand the shocks and jars transmitted upward through the pelvic girdle. These particular forces are amply cushioned by the action of the sacro-iliac ligaments and associated ligamentous structures. Thus, we have a most efficient shock-absorber in what casually appears to be an extremely rigid structure.



Antero-posterior section through the symphysis pubis.

The relation and direction of movement in the sacro-iliac joint is such that if the sacrum is backward the ilium is forward, or downward if the other is upward. We must remember at all times that immediately above and below the pelvic girdle we have particularly free mobility in the lumbo-sacral and ilio-femoral articulations which are capable of taking upon themselves greater functional demands than might ordinarily be expected and in that way of protecting the sacro-iliac joints from excessive functional strain.

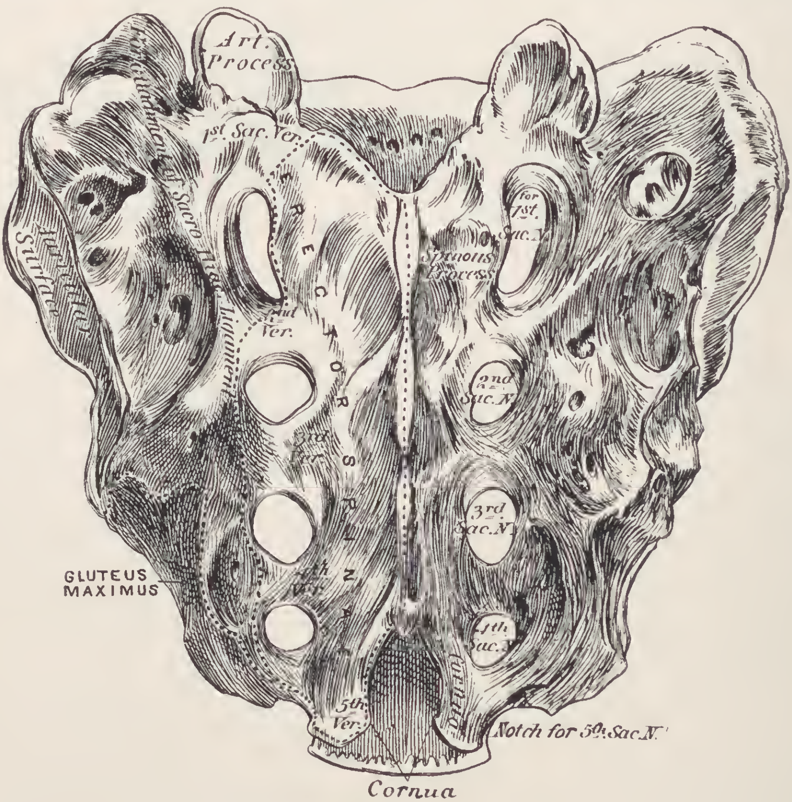
The relation of the legs and feet to the sacro-iliac joints is important when the arches are relaxed. There is an inward rotation of the leg with strain, tension and stretching of the external rotators. The inward rotation of the legs brings

constant stress upon the external rotators and, indirectly, via the fibers of the posterior capsular ligaments, separational strain is brought to bear upon the sacro-iliac articulations. Rotating the thighs outward as in regular rotation exercise for foot treatment tones up the external rotators.

The **pyriformis muscle** is the only muscle in the body whose attachments criscross in the pelvis. It is the chief stabilizer of the sacro-iliac joint laterally. A method for toning up this muscle is as follows:

The patient is prone, and rotates the leg outwardly against the resistance of the operator, who grasps the heel and holds the foot and toes inverted.

Pregnant women are prone to sacro-iliac subluxations



Posterior view of the sacrum.

because of the softened and relaxed state of their ligaments, particularly near parturition.

Dislocation of the sacro-iliac joint is very rare and usually fatal, due to tearing and injury of intra-pelvic and abdominal organs and the iliac vessels. Separation of the pubic bones in riders from the effects of a severe jolt has been reported by various authorities. It is a rare injury.

Ligaments of Importance: The posterior sacro-iliac ligament is exceptionally strong and is the chief bond of union between the sacrum and the ilium. It consists of three series of fibers: (a) superficial horizontal (b) deep horizontal (c) oblique. The superficial fibers connect the first and second transverse tubercles of the back of the sacrum to the tuberosity of the ilium and the deep fibers are immediately internal to the superficial. The oblique fibers connect the third transverse tubercle of the sacrum to the posterior superior spine of the ilium.

The **anterior sacro-iliac** is a weak ligament composed of thin bands attaching the anterior part of the sacrum to the pre-auricular sulcus and margin of auricular surface of the ilium.

The **great sacro-sciatic ligament** (ligamentum sacrotuberosum) arises from the fourth and fifth transverse tubercles of the sacrum, from the spine of the ilium, sacrum and coccyx and passes downward, outward and forward to be inserted into the inner margin of the tuberosity of the ischium.

The lesser sacro-sciatic ligament (ligamentum sacrospinosum) arises from the lateral margin of the sacrum and coccyx and is inserted into the spine of the ischium. Both sacro-sciatic ligaments act as check ligaments for flexion of sacrum.

The **lumbo-sacral ligament** arises from the transverse process of the fifth lumbar vertebra and attaches to the base of the sacrum laterally and anteriorly.

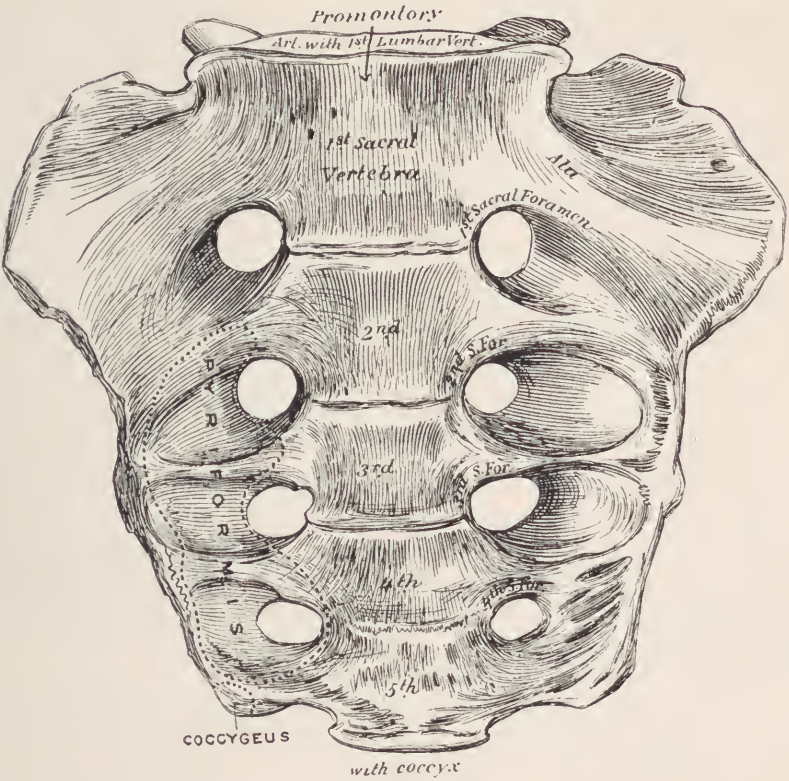
The **ilio-femoral ligament** is the strongest ligament in the body. It attaches above to the anterior inferior iliac spine. Below it is Y-shaped, one band attaching to the great trochanter and the other to the intertrochanteric line. The ilio-femoral ligament is the chief agent in maintaining the erect position, without muscular fatigue or effort, for a perpendicular line passing the center of gravity of the trunk falls behind the center of rotation of the hip joint. Therefore, the pelvis tends constantly to fall backward, but is prevented from so doing by the tension of the ilio-femoral ligament.

The **ilio-lumbar ligament** arises from the front part of the body of the fifth lumbar vertebra; laterally it divides and is attached by two bands to the ilium. Other ligaments of less importance will not be considered here.

Lesions of the Sacro-Iliac Articulation:

1. Positional, as regards the sacrum.
   (a) Bilaterally Anterior Sacrum
   (b) Bilaterally Posterior Sacrum
   (c) Unilaterally Anterior Sacrum
   (d) Unilaterally Posterior Sacrum

2. Positional, in the same order as above but from the standpoint of the innominates.
   (a) Bilaterally Posterior Innominates
   (b) Bilaterally Anterior Innominates
   (c) Unilaterally Posterior Innominate
   (d) Unilaterally Anterior Innominate
   (e) Combined Unilaterally Posterior (one side), Unilaterally Anterior (opposite side). This is a true form of the twisted pelvis.
   (f) The Pseudo-Twisted Pelvis. This is an apparent asymmetry of the pelvis due to imbalanced lumbar muscle tensions, subluxations of the fifth lumbar, etc. It is not a true pelvic twist inasmuch as it is secondary and more or less counterbalancing and exists without lesion of the sacro-iliac articulations.



The sacrum, anterior view.

The Bilaterally Anterior Sacrum (Syn. Bilaterally Posterior Innominates). This lesion is characterized by a slight arthrodial slippage downward of the sacrum on the ilia, together with a rotation on a transverse axis through the posterior sacro-iliac ligaments in such manner as to allow the base of the sacrum to rotate forward and slightly downward. This movement is therefore essentially a forward, downward movement of the sacrum or a backward, upward movement of the innominates. The ligaments in connection with this joint may be placed on tension or relaxed according to whether their attachments are approximated or separated.

Etiology: The majority of predisposing factors are chronic in character, their formation being due to a long continued process of structural changes. A few of the causes follow:

Faulty posture, that type particularly associated with pot belly and lumbar lordosis.

Factors which bring the vertical line of gravity anterior to normal, such as extreme cases of the straight spine, in which the normal lumbar curve is lost or reversed. We must not forget the mechanical influence of the normal lumbar curve in the transmission of the superincumbent weight and the maintenance of the transverse axis for movement of the sacrum.

A relaxed or atonic posterior sacro-iliac ligament must allow a certain amount of yielding in such a direction as to tend to produce this type of subluxation.

A small percentage of bilaterally anterior sacrums may be due to traumatisms, falls, etc.

The reason for the much greater percentage of anterior lesions of the sacrum is because of the direction of the lesioning forces in relationship to the pelvic structures and their articulations. Forces directed upward through the acetabulum tend to force the innominates upward and backward. The superincumbent weight falls upon the base of the sacrum and this, of course, tends to force the sacrum downward through a combination of arthrodial and rotary movements.

Diagnosis: The lesion is more common than the diagnosis. This is probably due to the fact that asymmetrical findings are not evinced and, therefore, the lesion frequently eludes the notice of the examiner. These lesions are common and frequently antedate unilateral lesions. The two most noticeable factors in diagnosis are the increase in the sacro-vertebral angle and the decrease in the

pelvic inclination (the normal is 30 to 40 degrees in the horizontal position, before backward, line drawn from the symphysis pubis, through the posterior superior spine of the ilium). The antero-posterior diameter is lessened (the normal is $4\frac{1}{4}$ to $4\frac{3}{4}$ inches). The base of the sacrum is downward and forward and the apex is upward and backward. The posterior superior spines are more prominent posteriorly and are approximated, (the normal separation being $3\frac{1}{4}$ to $3\frac{3}{4}$ inches). The iliac crests tend to flare more superiorly and the anterior superior spines are farther apart (the normal distance being from $8\frac{1}{2}$ to $9\frac{1}{2}$ inches. The fifth lumbar has the appearance of being markedly anterior, the spine of the fourth overlapping the fifth and approximating it. With the patient supine, both feet are strongly everted, due to the tension pull of the sartorius muscle. The apex of the angle formed by the junction of the ilium and sacrum (the sacro-iliac X) is more acute and is the seat of localized tenderness. In bilateral lesions both junctions are tender on their posterior aspects. The sacro-tuberous and -spinous ligaments are tensed as well as the fascia between the ischial tuberosity and the lower portion of the sacrum and coccyx. Motion is restricted equally in both joints and in all directions.

Treatment: Patient prone. The legs should be slightly abducted and feet everted. Using a Taplin table and a Taplin mobilizer, rocking the sacrum backward and forward will normalize mobility of both sacro-iliac joints simultaneously. In this particular case the operator should mobilize downward with force directed against the apex of the sacrum. This type of technique is particularly efficient, easy of accomplishment, and should be used as the method par excellence in treating a heavy patient.

On a straight table a pillow should be placed under the thighs to obtain ilio-femoral leverage. The operator should then direct corrective pressures to the apex of the sacrum. In an extremely stubborn lesion, the operator can, by stand-

ing on a stool at the side of the table, apply pressure with the knee against the apex of the sacrum, and allow freedom of the hands to exert outward and downward pressure against the ilia; thumbs behind the posterior superior spines, fingers along upper borders of the ilia. To enhance the value of this treatment instruct patient to place his hands on the table and slowly and strongly extend, as the operator applies extra pressure to the ilia, and return slowly to the prone position when extra-sacral pressure is applied to the apex.

Patient sitting astride the table at the extreme end. The operator holds the patient across the shoulders and bends him over backward to the degree necessary to bring strong counter pressure of the outer portion of the table against the posterior superior spines. The abducted position of the patient's legs brings strong ilio-femoral leverage on both innominates and superimposed upon this is the contact pressure against the posterior superior spines. This necessitates only slight increase in extension to carry the sacrum through the bilateral movement of extension. If the table is extremely wide, too much abduction will result and the interlocking effect of the heads of the femora will prevent easy reduction of the sacro-iliac subluxations because of lateral compression.

This lesion may also be corrected as a unilaterally posterior innominate of first one side and then the other. Predisposing causes must be thoroughly removed insofar as possible to obtain the best permanent results.

The Bilaterally Posterior Sacrum: (Syn. Bilaterally Anterior Innominates). This is an infrequent condition consisting of an upward and backward rotation of the base of the sacrum. It is an extension lesion of the sacrum. The false pelvis is broader, the diameter of the inlet larger, and that of the outlet smaller. Both innominates are forward and slightly downward. The reverse is true of the sacrum. The ligaments in connection with this

joint may be placed on tension or relaxed, according to whether their attachments are approximated or separated.

Etiology: The causes of the type of lesion are varied. A few of them are as follows. Faulty sitting posture, especially extreme slouching, with the weight resting on the apex of the sacrum, is predisposing. Bedridden patients who have spent a long time on their backs will develop this condition. Etherization without a lumbar pad may precipitate an acute lesion of this type as will also parturition. Unusual forms of trauma may produce it.

Diagnosis: In the main it is converse to that of the bilaterally anterior sacrum. The sacro-vertebral angle is decreased and the pelvic inclination increased. The fifth lumbar and the base of the sacrum are more prominent posteriorly. The apex of the sacrum is more anterior and the sacro-tuberous and -spinous ligaments are relaxed. The posterior superior spines are further apart, not so prominent and at a correspondingly higher level. The anterior superior spines, in relation to the posterior, are at a lower level and the distance between them is increased, although mensuration does not always show this, the difference being very slight at times. The crests flare more than normal anteriorly. With the patient on his back, the feet tend to relax in inversion. There is considerable tenderness along the inner border of the posterior portion of the crests of the ilia. The sacro-iliac junctions (sacro-iliac X) show a decrease in the acuteness of their posterior angles, the angles becoming more obtuse. Restricted motion is equal and the same in all directions. The nature of the predisposing causes may aid in the diagnosis.

Treatment: Patient prone. Using a Taplin table and a Taplin mobilizer the sacrum can be mobilized in the direction of flexion by directing the mobiliz-

ing force against the base of the sacrum in a downward, forward direction.

Using the straight table with the patient supine, the following method is satisfactory. Place a pillow under the anterior superior spines. Adjustive force is directed against the base of the sacrum in a downward, forward direction. This method can be made still further effective by counter force applied to the ischial tuberosities. This lesion may be adjusted unilaterally by using technique for reduction of the unilateral anterior innominate, first on one side and then on the other.

The Unilateral Anterior Sacrum: (Syn. Unilateral Posterior Innominate). This lesion is a torsion movement on an oblique axis approaching the vertical which passes through the sacro-iliac articulation of the opposite side. A true rotation movement is not possible and the axis of the torsion movement is more or less a shifting one. The movement of the base of the sacrum is slightly forward and downward on the side of the lesion and is rotary and arthrodial in character. The portion of the sacro-iliac ligament allowing this movement is stretched and weakened. There cannot be a lesion on one side without compensatory changes on the other. The movement is complex and asymmetrical. There is a tendency toward separation between the sacrum and the ilia posterior on the side opposite the lesion and anteriorly on the side in lesion. This compensation partakes of the nature of an anterior rotation of the opposite innominate to re-establish stability and transmit superincumbent weight efficiently. This anterior rotation is secondary. Fixation is not present usually, and therefore it is not a lesion in a true sense. When spontaneous adjustment of the primary lesion occurs the secondary condition will automatically disappear. This, therefore, implies specific direction of adjustive energies to the primary lesion alone.

The fifth lumbar vertebra is maintained in side-bending rotation with the spine directed to the side opposite that of lesion. This is undoubtedly due to the tension pull of the ilio-lumbar ligament. Secondary lesions in the lumbar spine ensue as a result of the disturbance of equilibrium brought about by the pelvic asymmetry. It is very common to find a secondary third lumbar lesion compensatory to a lateral fifth; a second lumbar lesion compensating for a fourth.

The twelfth rib on the lesioned side is frequently subluxated by being pulled down by the tension of the quadratus lumborum muscle and of the lateral spinal muscles, which are often in a contractured state.

Etiology: Inherent muscular and ligamentous imbalances of the adjacent region are productive factors. Unequal ligamentous tone of the posterior sacro-iliac ligaments has a pronounced influence upon the functional welfare of the articulation. Traumatisms such as torsion forces (sudden wrenches, falls, etc.) are frequent causes. This type of lesion may also be associated with occupational and postural anomalies, scoliosis, functional curvatures, etc.

Diagnosis: Physical findings or, in other words, anatomical findings, are a probable indication as to the type and nature of the subluxation. Combined with functional or physiological findings they constitute a complete clinical diagnostic picture.

Physical findings: With the patient sitting, the posterior superior spine is more prominent, at a lower level and nearer the median line of the body. The sacro-iliac joint on the side of the lesion is more sensitive than its fellow. Tenderness of a lesser degree is frequently found on the side opposite the lesion along the inner border of the crest, which is characteristic of the anterior type of innominate subluxation.

With the patient lying face downward a compensatory functional curvature may evince itself, the convexity being on the side of lesion. This is due to the contractured state of the musculature of the lesioned side. The buttock on the subluxated side is at a lower level than its fellow. The respective shift in these levels may or may not be particularly noticeable.

With the patient on the back, the side opposite the lesion appears higher with the exception of the leg, which appears nearer to the table, due to the relative position of the acetabula. The ilium on the side opposite to the lesion flares more anteriorly and the anterior superior spine and crest is apparently at a slightly lower level. The side in lesion appears to hug the body more, making the hip appear smaller than its fellow. A demonstrable difference in the respective levels of the crests of the symphysis pubis is such that the side in lesion appears to be slightly elevated. The leg on the side of the lesion is shorter. This may be determined by drawing a line from the anterior superior spine or the umbilicus to the inner malleolus of each limb and comparing the length of both lines. The foot tends to evert due to the tension pull of the sartorius muscle. The side in gross lesion shows marked sensitiveness at the point of division of the gastrocnemius muscle. Standing, the shoulder of the patient on the side of lesion is lower than the opposite shoulder, although the crest of the ilium on the side of the lesion is apparently at a higher level than that of its fellow.

Diagnosis Based on Functional or Physiological Findings: Inasmuch as a sacro-iliac joint has a normal yielding range of combined arthrodial, rotary motion in an upward, backward, and a downward, forward direction this knowledge can be utilized diagnostically to advantage. By referring to this slight motion it is possible to determine, first, whether there is a fixation and secondarily, through comparative findings as to the range of motion of the opposite leg, to prove the relative position of

the leg in fixation. If the sacro-iliac joint is considered as having normal range of motion, necessarily our anatomical findings are dependent upon and must conform to its functional imbalance. A joint usually seeks as a resting point its central range of motion, but there is no law to prevent it, under certain circumstances, from resting in its uppermost or its lowermost range of motion and without transgressing the laws of normality. The essential physiological factor of any lesion is fixation and in the sacro-iliac subluxation its presence must be proven, as it is the positional situation; and, after adjustive procedures have been carried out, it must also be proven whether physiologic balance has been restored; in other words, equal mobility in the same and all directions. And if the condition be in the nature of an excessively relaxed sacro-iliac articulation with concomitant loss of tone in the sacro-iliac ligaments, hypermobility will be the physiologic finding and serve as an accurate indicator as to the exact character of the condition.

Normally the sacro-iliacs may assume diverse ranges of motion. Anatomical findings indicate this fact but do not determine definitely the presence or absence of lesion as they do not prove or disprove the presence of fixation. Assume, for example, the presence of a posterior innominate on the left with fixation in that position. However, as the opposite leg might at the time of examination be in its posterior range of normal yielding motion, the anatomical findings would tend to be equal and symmetrical and would fail of a correct diagnosis if the operator depended entirely upon the anatomical situation. On the other hand, if, by the use of easy leverage forces, an operator may shift the position of the innominates anteriorly or posteriorly as desired and thereby create almost any type of positional anomaly, and, moreover, if he can by the same use of leverage in the case of a unilateral lesion and its resultant pelvic asymmetry, create symmetry and apparent normality anatomically by directing easy leverage forces through the opposite innominate, the importance of the functional finding is apparent.

A standard upon which to build our diagnostic findings must be established. Anatomical findings alone are variables; they are not fixed standards. Physiologic findings are true indicators of the presence or absence of fixation and, using the method which will be later described, are a correct index as to the type, degree, and position of the lesion. Superimposed, the physical findings are an admirable check upon the primary diagnosis.

The author uses a method which will give a complete functional analysis of both sacro-iliac articulations. This is part of a routine examination in the case of any pelvic asymmetry when it is desired to establish or rule out the presence of a sacro-iliac lesion. Two different types of combined leverage force are possible. The one that gives the greatest range of motion possible to the innominate in a downward, forward direction is the combined leverage-force of the posterior fibers of the capsular ligament plus those of the ilio-femoral ligament. The combined tension leverage of these two ligamentous structures is produced by first bringing the leg across the median line, which tenses the posterior fibers of the capsular ligament and produces a separational strain at the sacro-iliac articulation, and by then superimposing the pull of the ilio-femoral ligament by external rotation of the already adducted leg and thigh. The one that gives the greatest range of motion possible to an innominate in an upward, backward direction is the combined leverage effect of the capsular ligament plus the external rotators of the thigh. This combined tension leverage is produced by abducting the leg and thigh and internally rotating them while in this position. Capsular ligament tension, as in the aforementioned case, is of value in that it tends to focus separational strain upon the sacro-iliac articulation. The external rotators are the means by which rotary and arthrodial leverage necessary to bring the innominate to its uppermost backward range of motion is applied. The pyriformis and the obturator internus muscles are added potential forces

in the production of this leverage. The position of the leg in both cases is such as to tend to bring valuable resultant forces into action in the first procedure in a downward direction, and in the second procedure in an upward direction. The routine method of procedure, as used by the author, is as follows:

Position of leg and thigh in relation to the torso to effect shortening of the leg through forward rotation of the innominate. Capsular ligament tension leverage particularly through the ilio-femoral ligament is the means by which the above rotation is accomplished. A, B and C indicate the direction of rotation of the thigh and leg.

Lengthening procedure for one leg and shortening procedure for the other, gives the total range of disparity of movement in one direction. Reversing the procedure by lengthening the leg previously shortened, and shortening the leg previously lengthened, gives the total disparity of movement in the opposite direction. Providing the entire range of disparity in both directions is equal and moreover will evince a total difference of from one to two inches in the respective levels of the inner malleoli, one may clinically assume a normal sacro-iliac joint. A bilateral decrease in motion of less than an inch is significant of bilateral restriction of movement in the sacro-iliacs. A bilateral increase in motion in which the total disparity in both directions is greater than two inches indicates hypermobility of both. A difference in the respective totals of disparity of movement in both directions indicates fixation in the direction of the lesser of the two. This means that either the leg to which the shortening leverage was applied is fixed in an anterior position, or that its fellow, to which lengthening leverage was applied is immobilized in a posterior position. The next step in the procedure is to rule out fixation either of the anterior innominate or the posterior innominate of the opposite side. Using the lengthening leverage if the fixation is a posterior one, the leg on the side in lesion will refuse to lengthen, but by shortening it both malleoli will assume the same level. This is functional evidence of a unilateral posterior innominate. On the other hand, if both legs lengthen but one leg refuses to shorten, the functional evidence points to an anterior innominate on that particular side. If, however, with the use of bilateral lengthening and bilateral shortening, the display still remains, this gives evidence of a unilaterally posterior innominate on one side, and unilaterally anterior innominate on the other. Pelvic asymmetry is constant in this instance, in contradistinction to the case of the unilateral lesion in which pelvic asymmetry may be temporarily eliminated, for if one innominate is fixed posteriorly and the shortening

leverage is applied to the other leg, pelvic symmetry will result; the reverse is true in the case of anterior innominate fixation in which a lengthening leverage applied to the opposite leg to induce seeming pelvic symmetry.

Position of the leg and thigh in relation to the torso to effect shortening of the limb through backward rotation of the innominate. Capsular ligament and external rotator leverage is the means by which the above rotation is secured. A, B and C indicate the direction of rotation of the thigh and leg.

The pseudo-twisted pelvis, in which there is no sacro-iliac fixation, can be automatically and quickly eliminated, inasmuch as pelvic symmetry is noted when both innominates are carried bilaterally anterior and bilaterally posterior with their corresponding leverage control; and, moreover, the total disparity of movement in both directions is equal. Bilateral-

ly posterior innominates will show no response to lengthening leverages and the total disparity of movement will be so slight as to indicate double fixation, although equal in both directions. The opposite picture obtains in the functional findings associated with bilaterally anterior innominates.

Studies of the posterior superior iliac spines and their action under the use of these leverage forces is interesting as well as instructive. By alternately using bilateral shortening and bilateral lengthening measures, the posterior superior spines can be brought from greatly exaggerated approximation to widely marked separation (approximately ½″ to 1″ normally). The application of unilateral leverages to the innominate will correspondingly change its position and compel it to assume the characteristic position of either the anterior or posterior innominate, depending upon the type of leverage used. Other palpable anatomical features will likewise assume a position commensurate with the change of position at the base; in other words, the sacro-iliac joint.

Treatment: **Technique No. 1.** Patient prone. If a straight table is used, place a pillow under the thighs with legs maintained in slight abduction and feet everted, particularly on the side of lesion, as this will tend to bring leverage-force through the ilio-femoral ligament. Adjustive force is directed against the posterior superior spine of the ilium in a downward, lateralward direction. Counter adjustive force is applied against the apex of the sacrum, or in other words that section of the sacrum below the axis of rotation. The heel of each hand is the medium through which corrective force can be effectually administered. This is accomplished by placing the heel of the hand against its appropriate objective. As there are two objective points against which force is to be directed, both hands are utilized and both adjustive forces are delivered synchronously. Using a Taplin table, a pillow is not necessary. In fact, rocking the sacrum between the innominates with the use of the Taplin

mobilizer often serves to break the fixation and restore a normal range of movement to the sacro-iliac joint, rendering further adjustment unnecessary.

Technique No. 2. Patient supine. If straight table is used a pillow is placed under the sacrum and posterior superior spines. The operator stands beside the patient on the side of the lesion. Flex the leg on the thigh, and the thigh on the abdomen, slightly beyond a right angle with the table so that the point of the flexed knee is in the same vertical plane as the highest portion of the iliac crest. From this point without changing the vertical plane, adduct to the medial plane or midline of the body so as to bring strain on the posterior fibers of the capsular ligament. Interlock the fingers and with this particular instrumentality make a thrust downward on the flexed knee so that the force will pass approximately through the long axis of the femur. This force is transmitted through the long axis of the femur into the acetabulum in such manner and direction as to force backward that portion of the innominate below the axis of rotation which in turn means reverse rotation of that portion above this axis. Superimposed upon the adjustive force is passive counter force, made possible by the fact that the point of maximum contact with the table is the posterior superior spine. The thrust should be given at the end of expiration.

Technique No. 3. Patient supine, with lesioned side near the lateral edge of the table. Operator on the same side facing the patient. Fingers of the proximal hand are placed beneath the greater trochanter and cupped in such a manner as to secure a tremendous leverage by interposing a fulcrum between the trochanter and the pelvis at that point. The leg and thigh on the side of lesion are then flexed at right angles with the table and abducted to the point of limitation. The same degree of flexion must be maintained throughout this maneuver, so the weight of the abdomen is brought against the knee to stabilize the extremity in this position. The other hand is then utilized to hold the opposite innominate firmly

Position for adjustment of a unilaterally posterior innominate. Force is delivered in the direction indicated by arrow D through the long axis of the femur. This force is opposed by counter force as the posterior superior spine is in contact with the table on the side of lesion. Arrow B indicates direction of this force.

to the table with its thumb over the pubes and fingers along the crest of the ilium. The thumb over the pubes helps to determine whether motion is being re-established. Slight exaggeration of force directed at all three points, that is to say, slight exaggeration of the abduction of the leg with abdominal pressure, an increased pressure lift with the fingers underneath the greater trochanter and counter force by exaggeration of the fixation of the opposite innominate will serve to force the innominate forward. To complete the procedure, the hand underneath the greater trochanter is shifted so as to bring pressure on the abducted knee, relieving the abdomen from further duty. The hand maintaining the fixation of the opposite innominate is released so that the leg slightly above the ankle joint can be firmly grasped. Maintaining abduction, the patient is requested to kick straight out violently, and at the same time the operator gives a strong pull to the lower limb. The first effect of this leverage is to break fixation by bringing a tremendous rotary leverage through the ilio-femoral ligament. The latter part of the procedure tends to bring the sacro-iliac joint, the acetabulum, and the long axis of the leg into a common vertical plane. The combination of these actions serves to force the sacro-iliac joint to rotate anteriorly.

Technique No. 4. Patient supine. Flex the leg and thigh to a right angle with the body and attempt forcible external rotation of the thigh in that position. Maintaining these forces, straighten the flexed thigh. All this should be done in the midline. The forcible attempt at external rotation on a short axis exerts tremendous leverage on the ilio-femoral ligament when followed by extension of the thigh. The knee during this procedure is flexed and abducted across the median line. It is the lever handle through which these forces are secured and applied.

Technique No. 5. Patient on the side, lesioned side uppermost, with knee and thigh flexed to right angle. The flexed knee is maintained in firm position by the abdomen of the

Position of the leg and thigh in relation to the torso necessary to evoke greatest possible leverage of the ilio-femoral ligament for adjustive purposes. Arrow A indicates direction of leverage pull of ilio-femoral ligament. Arrow B indicates right hand which is cupped beneath and behind the greater trochanter acting in the nature of a fulcrum. Arrow C indicates direction in which lever is carried. Note abduction of the leg and external rotation of the thigh.

operator. The latter places his proximal hand over the posterior superior spine. With the opposite hand, he grasps the foot at the ankle joint and inverts it strongly. He then flexes the foot and knee to a point of easy limitation. With the lower leg as a lever handle, he attempts to circumduct the knee joint. With the knee locked in flexion, this results in a transference of this force to the acetabulum bringing about a leverage tension of the external rotators of the thigh and posterior fibers of the capsular ligament. This results in a gapping of the sacro-iliac articulation. At the summit of this separational strain the foot is suddenly jerked straight down in the long axis of the torso. The snap-of-the-whip effect of the latter procedure superimposed upon the gapping strain of the former is sufficient to produce an anterior rotation of the innominate, breaking fixation and reestablishing physiologic normality.

Technique No. 6. Patient on the side, in a modified Sim's position, lying upon under arm, with that arm extended backward and with legs and thighs both flexed. Operator stands behind patient and places the flexed knee against the posterior superior spine of the innominate in lesion and grasps the flexed knee of lesioned side with the adjacent hand. His other hand he places against the dorsal aspect of the uppermost scapula merely to exert a fixed point of stabilization pressure. The lesioned leg and thigh is flexed on the abdomen slightly beyond a right angle, is then strongly abducted, and, thereupon brought backward and downward, behind the under leg in a shearing manner so that at the end of the procedure it is in an extended, abducted position. The posterior superior spine and the scapula are maintained as fixed points during this procedure, offering resistance in such manner as to make the leverage forces possible. Moreover, they obviously render the adjustment easier through the maintenance of a counter force against the posterior superior spine of the innominate. The latter part of the procedure brings leverage force to bear through the psoas

Position for adjustment of an innominate immobilized in upward, backward rotation. B indicates sacro-iliac articulation, and D pivotal point for action of lever handle C. Circumduction of the latter determines rotation of the femur on its long axis and tension leverage of the posterior fibers of the capsular ligament and external rotators. This composite action causes a gapping strain at the sacro-iliac articulation. When separational strain is at its maximum a straight pull of the leg (arrow A) determines anterior rotation of the innominate to complete adjustment.

major muscle. This leverage is incidental but its influence on the sacrum is to stabilize the latter.

Technique No. 7. Patient standing, face to the wall. Make pressure against the posterior superior spine in lesion and counter extension of the thigh on the same side, being careful also to obtain a slight amount of external rotation of the thigh and abduction of the leg. Exaggerate both forces simultaneously to complete adjustment. This method is crude but effective.

Technique No. 8. Patient sitting up. Swart's strap technic for the posterior innominate is of value. It consists in passing the strap across the lesioned hip just below the crest of the ilium and on the opposite side above the iliac crest (so the strap in the latter instance does not touch the ilium) and then by carrying it around the patient's heel on the side of lesion. The strap is thereupon buckled, short enough so that the leg is about one-third flexed. The patient should then attempt to straighten the leg by forcible pressure against the strap.

Before or after correction of the innominates the fifth lumbar vertebra must be corrected as there is always an accompanying twist of this segment, its spinous process being to the side opposite that of lesion. In this connection attention should also be directed to the twelfth rib which is many times pulled down by contraction of the quadratus lumborum muscle.

The Unilateral Posterior Sacrum: (Syn. Unilateral Anterior Innominate). This lesion is a torsion movement on an oblique axis which approaches the vertical and passes through the long axis of the sacrum slightly posterior and mesial to the sacro-iliac articulation on the side opposite that of lesion. This is a shifting axis. The movement of the base of the sacrum is slightly backward on the side of lesion; a weakening of the posterior sacro-iliac ligament allows this move-

ment. Pelvic asymmetry of a complex nature is the result of the primary fixed anterior innominate of the lesioned side and the secondary compensatory posterior position of the innominate on the opposite side. The secondary lesion is seldom immobilized and usually does not demand adjustive measures.

The fifth lumbar vertebra is maintained in side-bending rotation with its spine directed toward the side of lesion. This is due to the relaxed state of the opposite ilio-lumbar ligament with a resultant secondary tonic tension pull of the ligament on the side of lesion. The pelvic asymmetry, by disturbing equilibrium usually occasions other compensatory lumbar lesions above the level of the fifth.

The twelfth rib may or may not be in lesion. When a posterior innominate is primary the lesion is quite common but it is much less common when the posterior innominate is a secondary, compensatory factor.

Etiology: Imbalanced muscular and ligamentous tension, (particularly unequal tone of the posterior sacro-iliac ligaments,) are productive etiologic factors. Traumatisms partaking of the character of torsion forces such as sudden wrenches, falls, blows, etc., are frequent causes. The character, nature and direction of the lesioning force will sometimes be an indication as to the nature of the subluxation. Such a lesion may have an occupational or postural source; it may be secondary to scoliosis, functional curvature, etc.; it may be due to atonicity of the extensors or hypotonicity of the flexors, or it may be included in a marked lordosis of the lumbar column, effecting an extension, either bilateral or unilateral, of the sacrum. When a straightening of the lumbar spine is not sufficient to produce extension or to include the sacrum in its posterior deflected swerve, it is a lesioning factor for production of the bilaterally anterior or unilaterally anterior sacrum. It is evident, therefore, that the effect of such

totally diverse conditions depends entirely upon the degree and extent of this lordosis insofar as it may involve the sacrum in its posterior deflection.

Diagnosis: The physical anatomical findings in combination with the functional, physiological diagnostic signs will give a complete clinical analysis of the condition. The physical findings are as follows:

With the patient sitting the posterior superior spine is less prominent, at a higher level and also further away from the median line of the body than normal. There is usually marked sensitiveness along the inner border of the iliac crest. With the patient prone a compensatory functional curvature may or may not be apparent concave on the side of lesion. The buttock on the subluxated side is at a slightly higher level than its fellow.

With the patient supine the thigh on the side of lesion appears higher than that on the normal side, except the leg, which appears nearer to the table, due to the relative position of the acetabula. The ilium on the anterior side flares more anteriorly and the anterior superior spine is apparently at a lower level. The ilium of the opposite side flares less and appears to hug the body more, causing the hip of that side to appear smaller than its lesioned fellow. The respective levels of the crests of the symphysis pubis are such that the side in lesion is slightly depressed. The leg on the side of the lesion is longer, as is shown when lines are drawn from the anterior superior spines or the unbilicus to the inner malleoli of each limb and their comparative length noted. The foot tends to invert on the side of lesion.

With the patient standing the high shoulder is on the side of the lesion although the crest of the ilium of that side is apparently at a lower level. Subjective symptoms vary and are not dependable. The operator should avoid the confusion which would exist in the diagnosis of the twisted pelvis as to whether the primary lesion is an anterior innominate on one

side or a posterior on the opposite by always conforming to physiologic findings and basing his differential diagnosis upon the results of such tests. Any attempt to base a diagnosis on subjective symptoms, sensitiveness, or amount of structural perversion in the case of the unilateral lesion is unsatisfactory. The leg opposite the one in lesion may be subject to a greater disturbance than the one in lesion. This is explained by the fact that compensatory to the fixation of the lesioned innominate is a resultant hypermobility of the opposite side, and, moreover, by the fact that such hypermobility may be productive of a greater disturbance than the immobilization.

The patient or the corsetiere will often notice that one hip is apparently larger than the other. This is characteristic of a twisted pelvis.

Physiological Findings: First seek demonstrable proof of the presence of fixation and the nature of position: (physiologic evidence of an anterior fixation). Superimpose upon the above finding a differential diagnosis through the physiologic evidence of free mobility of the opposite innominate. These findings combine to give an exact, correlated, clinical and differential diagnosis. The correct procedure for obtaining these findings has already been fully described.

Treatment: **Technique No. 1.** Patient sitting with back to operator. Grasp the innominate (iliac crest) firmly with the proximal hand so that the tips of the fingers are in the depression below the anterior superior spine, the palm along the crest and the thumb in the depression under the posterior superior spine.

(Note:---If the operator's hand is not large enough to encompass these points the hold may be modified to suit individual convenience. The patient is instructed to hold his arms across his chest. Next, the distal hand of the operator grasps

the patient's shoulder on the side of the lesion with the forearm against the latter's chest. The patient is then flexed from above downward in such manner as to produce a complete anatomical locking of the lumbar spine to a point including the lumbo-sacral articulation. This changes the axis of rotation of the sacrum from a normally transverse axis to a nearly vertical axis, passing through the long axis of the bone. Hold the innominates firmly and bring the patient forward to the limit of flexion. He is then instructed to relax thoroughly and allow his entire weight to rest upon the operator's forearm. From this point of extreme flexion rotation on a small arc is carried out toward the side opposite that of lesion, utilizing the long lumbo-sacral lever handle, thoroughly locked, being careful at no time during the latter part of this procedure to disturb primary lumbar flexion inasmuch as the unit action of this lever handle is dependent upon the locking in flexion from above downward and any shift in this flexion will immediately and automatically destroy the integrity of this unit lever handle. The vertical axis for rotation of the sacrum allows the sacrum to rotate unilaterally forward on the side of lesion which movement is automatically adjustive to that side, providing firm counter force or resistance is maintained in opposition against the anterior superior spine of the innominate on the side of lesion.

Technique No. 2. Patient on the lesioned side with the lower thigh and leg flexed strongly, leg on the thigh, thigh on the abdomen. The operator stands behind the patient and places his flexed knee against the base of the sacrum. One hand grasps the shoulder, firmly holding the torso in slight forward rotation of the uppermost side. The other hand grasps the flexed knee of the lesioned side firmly and exerts a quick strong adduction pull in an upward and backward direction. This brings tremendous leverage force to bear upon the posterior fibers of the capsular ligament of the hip joint and the external rotators of the thigh. The hand against the shoulder merely maintains a stabilizing and re-

sistance pressure against the upper torso in opposition to the adjustive forces.

Technique No. 3. Patient on the side, lesioned side uppermost. The upper thigh is flexed to a right angle with the torso, and the knee carried in flexion to a point of easy limitation, considerably beyond a right angle. The flexed knee is maintained in firm stabilization against the physician's abdomen. The operator places his proximal hand over the posterior superior spine. With the opposite hand he grasps the forefoot and inverts it strongly. With the foot and lower leg as a lever handle, he then attempts circumduction of the knee joint. With the knee locked in flexion this results in transference of the force to the acetabulum, bringing about leverage tensions in the external rotators of the thigh and posterior fibers of the capsular ligament, thereby producing a gapping of the sacro-iliac articulation. At the climax of this separational strain the foot is suddenly jerked downward and forward. The snap-of-the-whip effect of the latter procedure superimposed upon the gapping strain of the former is sufficient to cause a rotation forward of the acetabulum and consequently a backward rotation of the innominate above the axis of rotation.

Technique No. 4. Patient supine. Operator stands on the side of the lesion. He flexes the leg on the thigh and the thigh on the abdomen, slightly beyond a right angle with the table, so that the apex of the flexed knee is in the same vertical plane as the highest portion of the iliac crest. From this point he adducts across the middle line of the body, so as to bring the point of the flexed knee directly over the ilium of the opposite side and in the same vertical plane. Interlocking the fingers, and with this particular instrumentality at his command, he makes an oblique thrust upon the flexed knee in such a direction that the resultant force will pass through the lower abdominal quadrant of the side opposite the lesion. Through the medium of the external rotators of the thigh

and the capsular ligament of the hip adjustive leverage force is effective to the innominate in lesion.

Technique No. 5. Patient prone. If using a straight table, place a pillow under the thighs to protect the patient from inquiry through contact with the hard table surface. Adjustive force is directed against the posterior aspect of the tuberosity of the ischium. Counter adjustive force is applied against the base of the sacrum, or, in other words, that section of the sacrum above the axis of rotation. The heel of the hand is the medium through which this corrective force can be delivered most efficiently in both cases. This is done by placing the heel of the hand against the desired objective. As there are two objective points against which force is directed, both hands are utilized and both adjustive forces delivered simultaneously. Using a Taplin table and mobilizer, rocking the sacrum between the innominates will usually serve to break the fixation and render further treatment unnecessary.

Technique No. 6. Patient on the side, lesioned side uppermost. The operator flexes the upper thigh on the abdomen and stands between the patient's legs in such a manner as to bring additional pressure on the apex of the flexed knee by exaggerated flexion and adduction of the thigh. He then interlocks the fingers of both hands and brings the heel of the proximal hand against the anterior superior spine and the fleshy portion of the opposite forearm against the tuberosity of the ischium. Exaggeration of the flexion and adduction focuses leverage force against the innominate in lesion through the tension of the external rotators of the thigh and the fibers of the capsular ligament of the hip joint. Superimposed to this leverage force are the adjustive forces of the heel of the hand against the anterior superior spine, applied in a backward direction, and the fleshy portion of forearm against the tuberosity of the ischium given in a forward direction.

Position for adjustment of an innominate immobilized in forward, downward rotation. Leverage force of the external rotators is assured by extreme flexion of the thigh. Arrow A indicates direction of force against tuberosity of the ischium. Arrow B indicates direction of counter force against anterior superior spine.

The combined Unilaterally Posterior, Unilaterally Anterior Innominates: This is in reality a twisted pelvis inasmuch as one innominate is immobilized anteriorly and the other posteriorly. Asymmetry is constant. The axis for this torsion movement is oblique and nearly vertical, passing through the long axis of the sacrum.

The fifth lumbar vertebra is maintained in side-bending rotation with the spine directed to the side opposite that of the posterior innominate. Secondary lesions in the lumbar region of the spine ensue as the result of a gross disturbance of equilibrium. Each innominate lesion partakes of the nature and particular characteristics common to that type of sacro-iliac subluxation.

Etiology: Traumatisms in the nature of torsion forces such as sudden wrenches, falls, etc., are the most common causes. With the superincumbent weight off the pelvis and conditions favorable to the forcible shifting of the normal transverse axis for rotation of the sacrum to a nearly vertical one, the mechanical situation is then propitious to the production of such lesions.

Diagnosis: It is not necessary to enlarge upon physical or anatomical findings inasmuch as the condition combines, respectively, the findings characteristic to both an anterior and a posterior innominate.

Physiologic findings are an accurate index as to the nature of the condition. If, with the use of bilateral lengthening and bilateral shortening the disparity is constant, we have evidence of a unilaterally posterior innominate on one side and unilaterally anterior innominate on the other side. Pelvic asymmetry is constant. In contradistinction to the case of the unilateral lesion in which the pelvic asymmetry can be temporarily eliminated, the above method gives physiologic evidence of bilateral converse fixation.

Treatment: This lesion may be adjusted by unilateral means, that is to say, by adjusting each innominate separately.

Technique No. 1. The technique about to be described is for bilateral, simultaneous adjustment. It is as follows: Patient supine. The operator stands on the side of the anterior innominate. He flexes the leg of that side on the thigh, and the thigh on the abdomen slightly beyond a right angle with the table so that the point of the flexed knee is in the same vertical plane as the highest portion of the iliac crest. From this point he adducts it across the midline of the body so as to bring the point of the knee directly over the sacro-iliac articulation of the posterior innominate. Interlocking his fingers, with this instrumentality he makes a thrust downward on the flexed knee so that the resultant force will pass approximately through the lateral articulating portion of the sacrum of the latter side in an antero-posterior direction. Opposing this force is the shearing effect of counter force against the posterior superior spine of that side. This automatically takes effect from the fact that the posterior superior spine of the distal side is the major contact point of the pelvis on the table. These parallel forces will act in such manner as to correct the posterior innominate of the distal side. The oblique thrust upon the knee cap is directed in such manner as to deliver through the medium of the external rotators of the thigh and the posterior fibers of the capsular ligament of the hip joint adjustive tension leverage force to the anterior innominate of the proximal side.

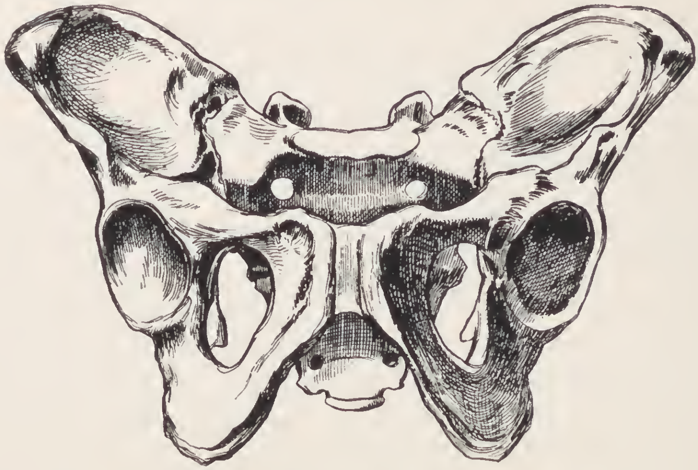
The Pseudo-Twisted Pelvis: This is an apparent asymmetry of the pelvis due to imbalanced lumbar muscle tensions, subluxations of the fifth lumbar, etc. There is no lesioning fixation of the sacro-iliac articulations; therefore the condition is secondary and in itself needs no adjustive attention.

Any existing confusion as to the nature of this condition

can be quickly eliminated by utilizing physiologic findings to prove or disprove the presence of fixation.

The Relation of Bryant's Triangle and Nelaton's Line to Sacro-Iliac Lesions: A line drawn from the anterior superior spine of the ilium to the most prominent part of the tuberosity of the ischium constitutes Nelaton's line. The very upper border of the great trochanter lies on Nelaton's line and this point is, moreover, on a level with the center of the hip joint---in other words, the center of the acetabulum. With the patient supine, Bryant's triangle is obtained as follows: A line is carried on a level with the anterior superior spine of one side across to the opposite side. Another line is continued from the anterior superior spine to the most prominent anterior point on the greater trochanter—almost coinciding with Nelaton's line. A third line is continued upward in the long axis of the femur from the most prominent point of the great trochanter. This line joins at right angles the first or perpendicular line. This third line is known as Bryant's line and is a means of measurement for determinating the amount of ascent of the greater trochanter in fracture and dislocation of the hip.

Because of the element of rotation that enters into sacroiliac subluxations, a certain amount of change and modification takes place in this triangle. When an innominate is immobilized downward and forward, Nelaton's line becomes slightly less oblique, tending nearer the horizontal, thus shortening Bryant's line in its corresponding relation to the perpendicular line. When an innominate rotates upward and backward, Nelaton's line becomes slightly more oblique, tending toward the vertical, and Bryant's line is lengthened relatively to that of the perpendicular line. The triangle is slightly enlarged in the former, and decreased in the latter. The relation of the trochanter to Nelaton's line remains unchanged, however.

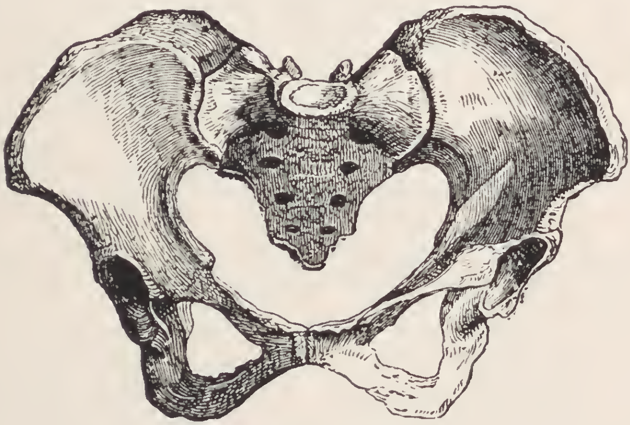


The male pelvis.

Sciatica is the pain-response of the sciatic nerve to irritation or strain. It may be the result of some disturbance in the static balance of the body, over exertion, exposure, etc. Pain in the back is invariably on the same side as the muscular overstrain or static anomaly. Constitutional predisposition or some acquired etiologic factor is generally in evidence, such as the osteopathic spinal lesion, infection, intoxication, worry, thermal influences, etc. Meteorologic changes primarily effect sugar tolerance and the resultant suboxidation induces a toxic state of the muscular tissue which renders it more liable to reflex irritability and contracture.

Localized lesions in the lower extremities or the back, including hip-joint trouble, rheumatoid arthritis, spinal disorders, flat foot, fractures, traumatic foot injuries, varicose veins, flail-joints, static weaknesses and gonorrhea are factors which, when localized on one side, correspond to the same side as that of the disturbed nervous mechanism. Their connection is unmistakable. The primary cause produces direct or indirect static insufficiency resulting in muscular strain, fatigue and irritation. A strained muscular function is significant as a factor in the production of neuritic symptoms. Lumbago in many cases can be traced to a primary muscle strain and secondary local neurotic symptoms. Pressure, chilling or a

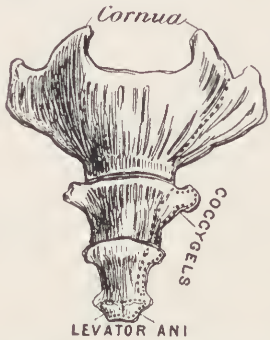
toxic state is responsible many times. Severe muscular effort may induce lumbago and, in severer cases, sciatica. A diminished or lost Achilles reflex, together with more or less anaesthesia, is suggestive of a neuritic tendency. A persistant sciatica is usually secondary and is indicative of an obscure chronic cause, or it has become a traumatic neurosis which can best be treated by suggestion as the neurasthenic element must be dealt with.



The female pelvis.

In hip joint disease pain in the knee is more or less symptomatic. This is usually localized on the inner side of the knee joint itself, due to the fact that both the hip joint and the knee receive their innervation from the obturator nerve. In disturbances of the sacro-iliac joint, reflex pain over the obturator nerve through the knee is frequently noted because of the close relationship of the nerve to that articulation, passing over it and occasionally distributing filaments to it. When the obturator nerve is paralyzed the patient is unable to press his knees together or to cross one leg over the other. When the anterior crural nerve is paralyzed the patient is unable to flex his hip completely.

Contracture of the pyriformis muscle has considerable influence upon the welfare of the sciatic nerve in that it passes behind and directly across the nerve and in a contractured state tends to bring pressure to bear upon it.



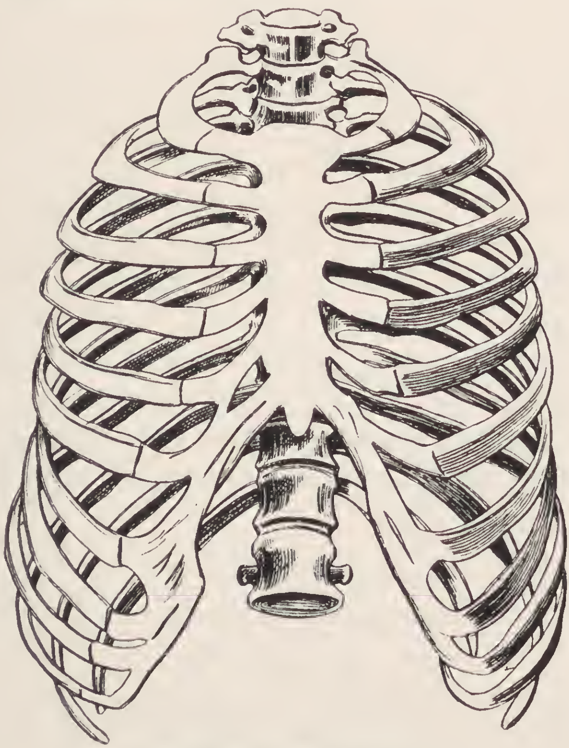
Coccyx, anterior surface. Anterior or lateral subluxation common. Reduced through rectal manipulation.

The deep portion of the fascia lata may become contractured through reflex innervation and because of its attachment to the border of the great sacro-iliac ligament produce some narrowing of the sciatic aparture and thereby produce a pressure effect on the sciatic. This pressure, although not great enough to cause sciatic irritability, is sufficient to impinge the artery and vein which continues along with it and thereby to produce nutritional impoverishment. Its nerve supply is derived from the lumbo-dorsal area and the range of the distribution of this disturbed innervation is such as primarily or secodarily to induce a twelfth rib lesion.

Chapter X.

COSTAL SUBLUXATIONS

Characteristics of a Typical Rib: Each rib presents two extremities, a posterior or vertebral, an anterior or sternal, and an intervening portion, the body or shaft. The vertebral extremity presents a head, neck and tuberosity. The head is characterized by a kidney-shaped articular surface divided by a horizontal ridge into two facets for articulation with the costal cavity, formed by the conjoint demi-facets on the contiguous thoracic vertebrae. The bisecting ridge serves for the attachment of an inter-articular ligament.



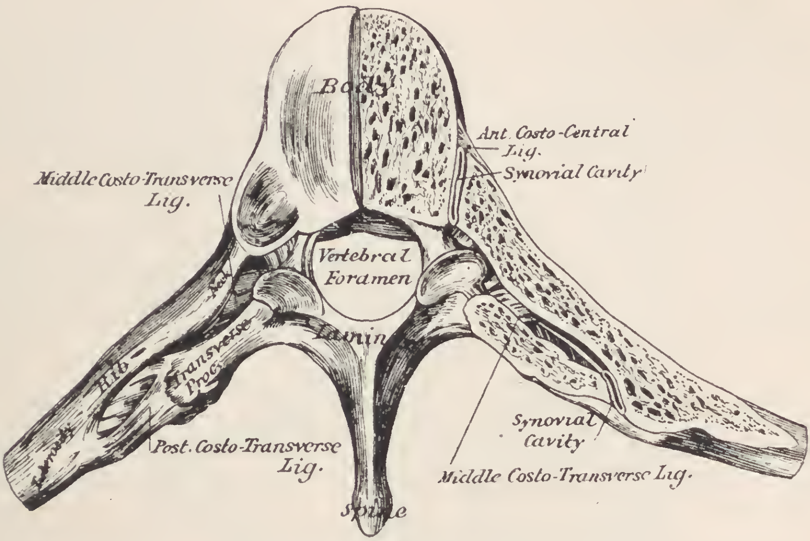
The thorax, anterior view.

The neck is constricted, flattened, extends laterally from the head, and is approximately an inch in length. It is placed

in front of the transverse process of the lower of the two vertebrae with which the head articulates. On the posterior surface of the neck at its junction with the shaft is an eminence, the tuberosity or tubercle, which consists of an articular and a non-articular portion, excepting in the case of the eleventh and twelfth ribs. It presents also a rough surface posteriorly for the middle costo-transverse ligament and a rough crest for the anterior costo-transverse ligament.

The anterior or sternal extremity is flattened and presents an oval, concave depression for the reception of the costal cartilage. The shaft is thin and flat, and presents two surfaces, an external and an internal, and two borders---a superior and an inferior. The external surface is convex and marked at its back part a little in front of the tuberosity by a prominent oblique line which gives attachment to a tendon of the ilio-costalis muscle and is called the angle of the rib. From this point the rib is bent in two directions so that its shaft as a whole is curved and slightly twisted upon its own axis. The internal surface is concave, smooth, and presents a ridge in front of the angle. The interval between this ridge and the inferior border presents a subcostal groove for the intercostal vessels and nerve. The superior border is thick and rounded and presents an external and an internal lip for the external and internal intercostal muscles. The inferior border at its posterior third presents a groove for the intercostal vessels and nerve and at its anterior two-thirds is sharp and thin.

The peculiar ribs are the first, second, tenth, eleventh and twelfth. The first is short, broad, has no angle and but one facet on the head. Its upper surface is marked by two parallel grooves, separated by a tubercle for the scalenus anticus muscle. In the posterior groove runs the subclavian artery and in the anterior the subclavian vein. The costal cartilage of the first rib is peculiar in that it is continuous with the sternum.



Costo vertebral articulations seen from above.

The second resembles the first in that it is flattened and not twisted. The tenth rib has but one facet for articulation with the tenth dorsal vertebra. The eleventh has a single facet on its head, a slight angle, but no tubercle or neck. The twelfth has a single facet, but no angle, tubercle or neck.

Articulations of the Ribs: The costo-vertebral articulations are divided into two sets.

(a) Those which connect the heads of the ribs with the bodies of the vertebrae---costo-central.

(b) Those which connect the necks and the tubercles of the ribs with the transverse processes---costo-transverse.

The **costo-central** joints have each a double arthrodial connection between the head of the rib and the bodies of the two adjacent vertebra, except the first, tenth, eleventh and twelfth ribs, which are united to the vertebral column by but a single joint. Its inter-articular ligament consists of a short

band of fibers attached by one extremity to the sharp crest which divides the two articular facets on the head of the ribs and by the other to the inter-vertebral disc, bisecting the joint into two distinct cavities. The first, tenth, eleventh and twelfth ribs have no inter-articular ligament.

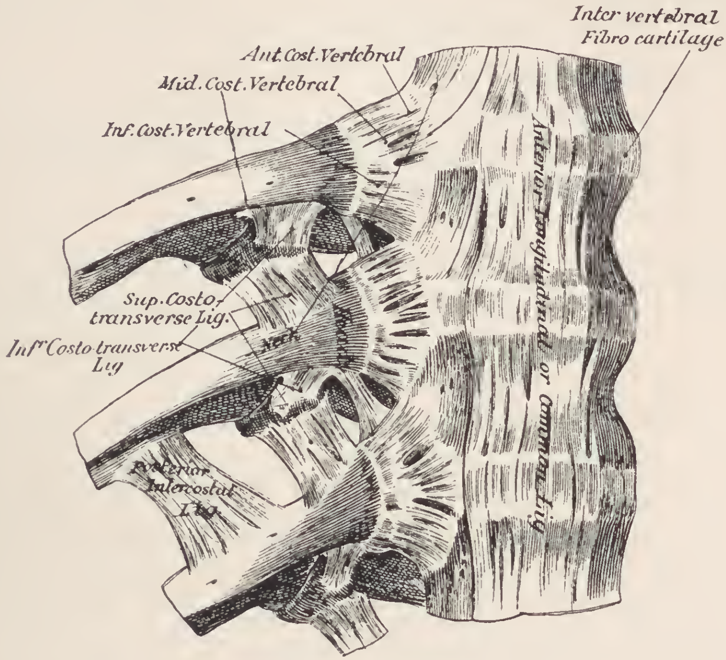
The **anterior costo-vertebral or stellate ligament** arises from the head of the rib, divides into three bands of fibers and inserts into the bodies of the vertebrae above and below and the intervertebral disc between.

The **capsular ligament** is a thin, loose, ligamentous bag, which surrounds the joint between the head of the rib and the articular cavity formed by the intervertebral disc and the adjacent vertebrae.

There are **two synovial membranes** in each of the articulations having an inter-articular ligament.

The **costo-transverse articulation** allows a slight amount of arthrodial movement and has: an anterior or superior costo-transverse ligament which stretches between the lower border of the transverse process and the sharp crest of the upper border of the neck of the rib; a middle costo-transverse or interosseous ligament, which consists of short but strong fibers connecting the posterior part of the neck of each rib and the anterior surface of the adjacent transverse process; and a third, the posterior costo-transverse ligament, a short, thick fasciculus which passes from the summit of the transverse process to the non-articular portion of the tubercle of the rib. The capsular ligament is a thin, membranous sack surrounding the articular surfaces and is lined by a synovial membrane.

The **costo-sternal articulations** of the true ribs with the sternum are arthrodial diarthroses with the exception of the first in which the cartilage is usually directly united to the manubrium, making it synarthrodial in character. The anterior chondro-sternal ligaments connect the chondral and



Ribs and corresponding vertebrae with ligaments; anterior view.

sternal surfaces in front. The posterior chrondo-sternal connect them behind. Capsular ligaments surround all and synovial membranes are present in all but the first. The second has an inter-articular ligament as well. The chondro-xiphoid ligament connects the cartilage of the seventh and sometimes the sixth rib with the xiphoid appendix. The interchondral and costochondral articulations are covered by the perichondrium and periosteum of the cartilages and ribs. The anterior articulations of the cartilages of the sixth, seventh and eighth ribs and sometimes those of the fifth and ninth, are connected by external and internal interchondral ligaments, held together by capsular ligaments, and each is lined by a synovial membrane.

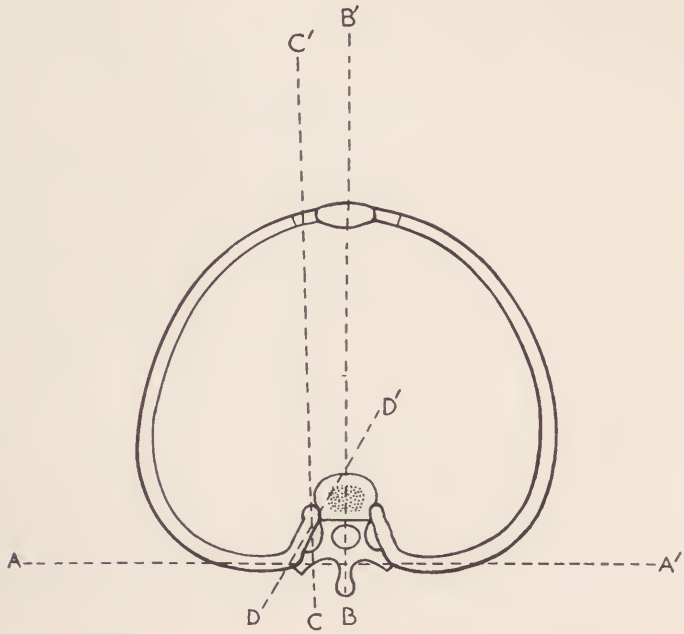
Costal Movements Movements of the ribs may be classified as follows:

1. Pump-handle.
2. Bucket-handle.
3. Combined bucket-handle and pump-handle.
4. Enarthrodial.

Pump-Handle Movement: In inspiration and expiration the ribs revolve on a transverse axis drawn through their costo-transverse and costo-vertebral articulations. This results in a rotation of the rib on a long axis, the tubercle and head of the rib acting in a hinge-like manner, the latter having also a screwing motion. This movement increases the antero-posterior diameter of the thoracic cavity and does not materially affect the transverse. The rib may be regarded as a radius moving on the vertebral joint as a center and allowing the sternal attachment to describe an arc with the vertical plane of the body.

Bucket-Handle Movement: In inspiration and expiration this movement is a rotation on an axis passed through an intermediate point between the costo-transverse and the costo-vertebral articulation posteriorly, and the costo-sternal articulation anteriorly. The movement in the costo-transverse articulation is such that the tubercle moves upward, backward, and medialward. The head of the rib moves downward, outward and backward. This movement causes an increase in the transverse diameter of the thoracic cavity and a decrease in the antero-posterior diameter unless associated with the pump-handle movement.

Combined Bucket-Handle and Pump-Handle Movement: This movement is a combination of the pump-handle and bucket-handle movement with an increase in all diameters. The primary motion is a pump-handle excursion and is followed immediately by the bucket-handle variation.



Diagramatic representation of axis of motion of the ribs. C to C′ represents antero-posterior axis for bucket-handle movement. D to D′ represents axis through the neck of the rib for pump-handle movement.

Enarthrodial Movement: This is peculiar to those ribs having free anterior extremities and which therefore permit slight movement in all directions, i.e., the eleventh and twelfth, or floating ribs.

The ribs are divided into three classes, according to their attachments:

1. Vertebro-sternal or true ribs---seven in number, each of which joins the sternum by a separate costal cartilage.

2. Three vertebro-chondral or false ribs immediately below, the cartilages of which join each other and with the seventh before uniting with the sternum.

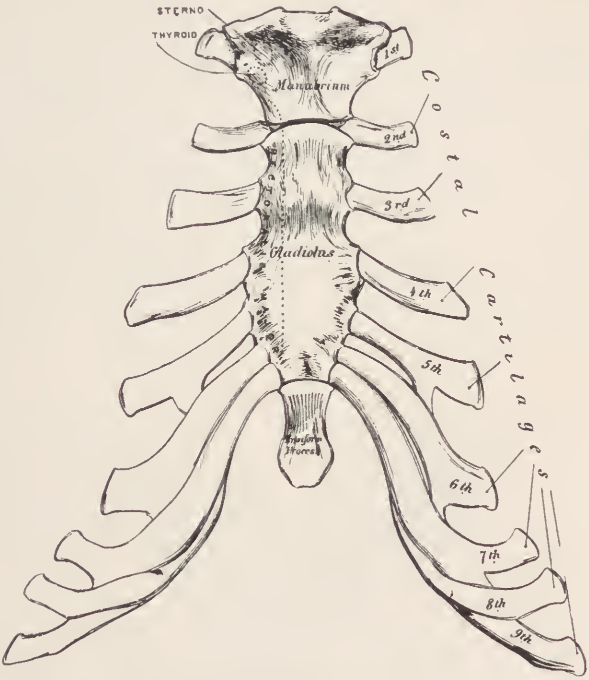
3. Two vertebral, free, or floating, which have no sternal attachments.

The Vertebro-Sternal Ribs: The **first rib** has pump-handle movement exclusively. Ordinary inspiration results in an excursion of the ribs in which the sternum is carried upward and forward by the action of the ribs immediately below. The first rib, of itself, enters into movement only passively. The action of the scaleni muscles in inspiration of a more or less forced costal type is such that when they contract they tend to cause a pump-handle movement of the first rib. When it has become stabilized in inspiration it can then serve as a fixed point for further action of the ribs below. Their pull is such as to cause its neck to rotate downward and backward on its long axis. The first rib is only dynamically concerned in respiration when the scaleni muscles take their fixed point from above, contract and elevate the first and second ribs. It must be remembered that the sternal end of the first rib is more or less fixed and for that reason the manubrium and rib tend to move as one piece. The head is very movable and has no inter-articular ligament. Movement of this rib results in an increase in the antero-posterior diameter of the upper thorax only.

The **second rib** has a less rigid sternal attachment, and the middle of the rib can also be drawn up, thus allowing a slight increase in the transverse as well as in the antero-posterior thoracic diameter.

The **third, fourth, fifth** and **sixth ribs** are elevated by combined pump and bucket-handle movements which increase all diameters. The primary movement is the pump-handle variety and this is followed by a secondary bucket-handle movement. Bucket-handle motion increases from above downward and pump-handle movement decreases in the same fashion until at the seventh rib the latter is entirely lost and superseded by the bucket-handle type. At the fourth rib both movements are approximately the same. Above that point there is a corresponding increase in pump-handle move-

ment; below it there is a proportionate decrease in the bucket-handle variety.



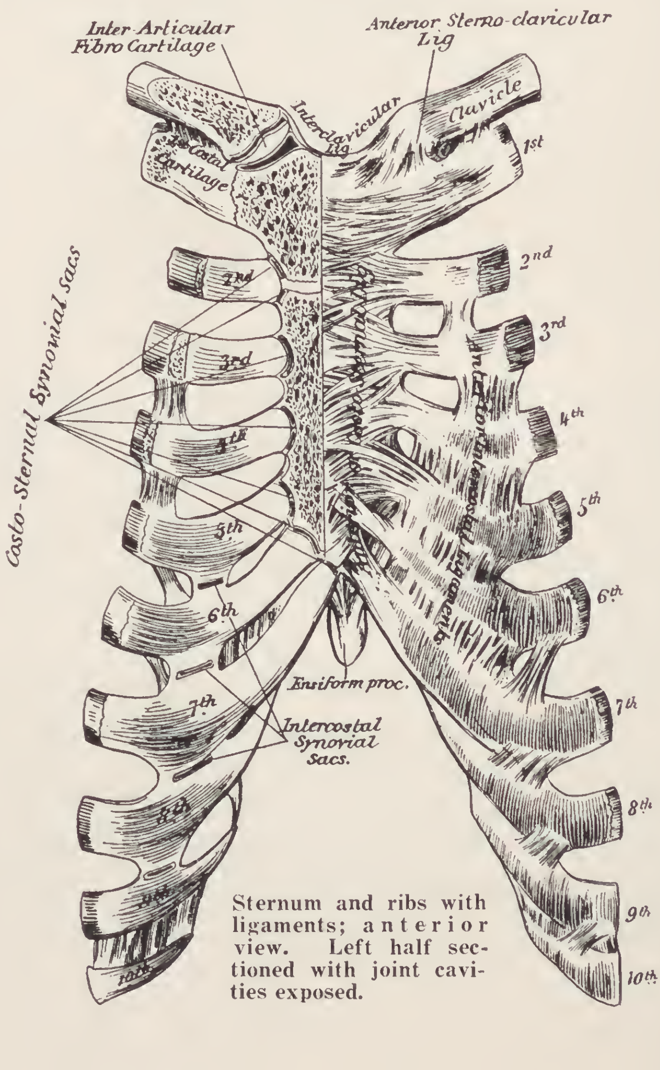
Anterior view of sternum and costal cartilages.

Vertebro-Chondral Ribs: The **seventh, eighth, ninth** and **tenth ribs** are elevated by a bucket-handle movement only, increasing the transverse and the lateral antero-posterior diameter, but decreasing the median antero-posterior diameter. With the exception of the seventh, which is a true rib, these costae belong to the vertebro-chondral order.

Vertebral Ribs: The **eleventh** and **twelfth,** or floating ribs have enarthrodial joints and are capable of slight movement in all directions. Normally they are depressed when the others are elevated to form fixed points for the action of the diaphragm. The tip of the twelfth rib usually lies two inches above the middle of the crest of the ilium.

Muscles of Respiration: They are divided into two general classes:
(a) Muscles of ordinary respiration.
(b) Muscles of forced respiration.

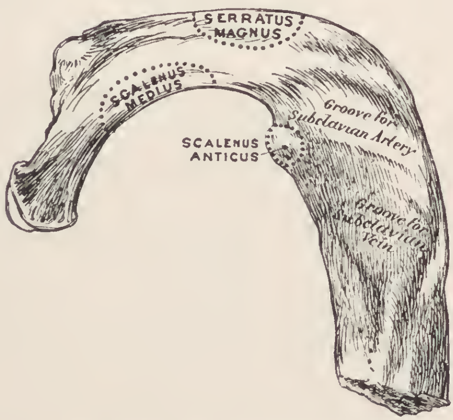
The muscles of ordinary inspiration are the scaleni group (anticus, posticus and medius). The serratus posticus (superior and inferior), external intercostals, levatores costarum, diaphragm and quadratus lumborum. The muscles of ordinary expiration are the internal intercostals. The muscles of forced inspiration are the pectoralis major and pectoralis minor, serratus anticus, sternocleidomastoideus, and the muscles which extend the cervical region. The muscles of forced expiration are abdominal.



Sternum and ribs with ligaments; anterior view. Left half sectioned with joint cavities exposed.

Lesions of the First Rib: 1. Pump-Handle Lesion: (Inspirational). A lesion wherein the rib is elevated anteriorly with a downward backward rotation posteriorly on the transverse process of the first dorsal vertebra. Although theoretically permissible it is rarely, if ever, found. Indeed, this lesion would be possible only through the pull of the scalenus muscle and its maintenance would depend entirely upon a retention of the fixed point above for the action of this muscle, which is unlikely. Due to the position of the attachments of the scalenus muscle the possibility of a slight amount of bucket-handle movement is problematical.

To the author's mind the motion of this rib is entirely pump-handle in character; and, moreover, his opinion is that, as far as inherent dynamics having sufficient control to produce an inspirational form of pump-handle lesion of the first rib is concerned, it is impossible. If one considers the full significance of this contractured state, its dependence upon a fixed point and the static or adynamic forces which constitute a powerful and ever present corrective factor, it is easy to realize the practical impossibility of immobilization in such a position.



Left first rib, superior surface.

2. Pump-Handle Lesion: (Expirational). A lesion wherein the rib is depressed anteriorly and rotates upward

and backward posteriorly on the transverse process of the first dorsal vertebra. This lesion is extremely common.

The defects in the upright position are important features in etiology. The spinal column, constructed to bear weight and sustain strain at a right angle, is obliged to do so in its long axis. The rib, which is more or less at a right angle to the spine was constructed to sustain strain in its long axis. It is obliged to do so at a right angle. Thoracic expansion has to work against gravity, and the weight of the anterior chest wall is such as to constantly bear down on the anterior extremity of the rib. Trauma, posture, and the adynamic forces of gravity are the usual causes of the lesion.

An **inspirational lesion** of any rib (second to the tenth, inclusive) is characterized by continued maintenance in forced or exaggerated inspiration. The axis of rotation of the lesion depends upon the particular rib involved.

An **expirational lesion** of any rib (second to the tenth inclusive) is characterized by continued maintenance or immobilization in expiration, the character of which may or may not be exaggerated. The atypical ribs (first, eleventh, and twelfth) in a modified manner, subserve a respiratory function.

Lesions of the Second to the Sixth Ribs, Inclusive:

These may be classified as follows:

1. Inspirational lesions:
   - (a) Pump-handle.
   - (b) Combined pump- and bucket-handle.
2. Expirational lesions (which occur in more or less reverse form).
   - (a) Pump-handle.
   - (b) Bucket-handle.
   - (c) Combined pump and bucket-handle.

Lesions of the Seventh to Tenth Ribs, Inclusive: These are either inspirational or expirational. The axis of movement is antero-posterior, making lesions in this area bucket-handle in type.

Lesions of the Eleventh and Twelfth Ribs: These may be in practically any direction, as these ribs have little capacity to move in all directions. They may be elevated or depressed, in or out, or rotated on their long axes. Their most common lesions are characterized by: (a) Depression and rotation on their long axes with their free ends downward, upper borders outward and lower borders inward. (b) Elevation and rotation on their long axes with free ends upward, upper borders inward, and lower borders outward.

An Inspirational Bucket-Handle Lesion may occur in any rib, second to the tenth inclusive, and is more common to the seventh, eighth, ninth and tenth costae. Movement is on an axis drawn from a point midway between the costo-transverse and the costo-vertebral articulations through the sternal junction, with consequent immobilization. The rib bulges laterally, the outer surface moves outward and upward, the lower border is everted and the upper border is inverted. There is separation from the adjacent rib below and approximation to the rib immediately above. Exaggeration of the lesion is obtained by forced expiration, in which the gross malposition of the rib can be better ascertained as the structural anomaly is thereby accentuated. Antero-posterior changes are not marked, as the total range of motion at these points is not great. The shaft of the rib, including the angle, having described the greater range of lesion movement, is the portion of the bone from which diagnosis is to be made. It can be best palpated under forced expiration by having the patient breathe out forcibly and sustain this position until examination is completed.

The Expirational Bucket-Handle Lesion occurs in the same ribs but movement is in reverse direction to the above.

Instead of the rib bulging laterally, it is apt to become proportionally less prominent in that direction. Its outer surface faces downward and outward, the lower border is inverted and the upper border is everted. There is separation from the rib above and approximation to the rib below. Immobilization of the costa can be determined by ascertaining the presence or absence of respiratory excursion. Exaggeration of the lesion is accomplished by forced expiration in which the gross malposition of the rib can be better ascertained as the structural malalignment is relatively magnified. This test can be best made by having the patient inspire forcibly and hold the breath until examination is completed. Antero-posterior changes are not marked; therefore the shaft of the rib, including the angle, is the portion of the rib upon which diagnosis depends.

The Inspirational Pump-Handle Lesion affects the first to sixth ribs, inclusive. The movement is characterized by rotation on a transverse axis, drawn through the costa-transverse and the costo-vertebral articulations with consequent immobilization in this position. The rib is elevated and slightly thrust forward anteriorly, with a downward and backward rotation of its neck on its long axis.

Antero-posterior changes are marked and are therefore the findings upon which diagnosis is based. The neck of the rib and its laterally continuous portion assumes a relatively lower level in relationship to the transverse process. This can be noted at the point of junction, where the rib passes in front of the transverse process of the vertebra. Posteriorly, the rib is approximated to the rib below, the costo-sternal junction bulges anteriorly, is approximated to the rib above, and separated from the one below. The position of the lateral portion of the shaft of the rib is not modified sufficiently to make it of diagnostic value. Exaggeration of the lesion is accomplished by forced expiration and can best be determined by making an examination at this time, if the patient will sustain the expiratory state for a short period.

Demonstrating lateral view of the normal spine with the normal antero-posterior curves straightened. The ribs are in an elevated state showing their relative position when in deep inspiration. Dorsal flexion increases when the ribs go into inspiration, although it is impossible to show this on the flexible spine.

The Expirational Pump-Handle Lesion.---This occurs in the same ribs, but by means of a reverse type of rotation, causing the rib to be depressed anteriorly with an upward, backward rotation of its neck on its long axis. Immobilization of the costa can be determined by ascertaining the limitation of the rib in respiratory excursion, particularly inspiration. If the patient will sustain the inspiratory state for a short period, the exaggerated state of the lesion can be noted.

Diagnosis is based upon antero-posterior changes. The neck of the rib and its laterally continuous portion assume a relatively higher level in relationship to the transverse process of the vertebra with which it articulates. Evidence of this can be had at the point of junction where the rib passes in front of the transverse process of the vertebra. Posteriorly the rib is approximated to the rib above, and anteriorly the sternal junction is depressed, approximated to the rib below and separated from the one above. The lateral portion of the shaft of the rib is of little diagnostic value as it is not positionally modified to any very appreciable extent.

The Combined Pump and Bucket-Handle Lesion may occur in any rib from the second to sixth inclusive. Movement takes place on both the pump- and bucket-handle axes, causing a combined lesion with the combined diagnostic features of pump- and bucket-handle lesions. These lesions may be inspirational or expirational; one type describing a reverse arc of movement to the other.

Etiology: Rib lesions may be primary or secondary. The theory sometimes advanced that the rib lesion is always secondary to a vertebral subluxation is without logical foundation. If a rib lesion is primary, it is a leverage force upon the vertebra with which it articulates and that vertebra will, by the action of the long lever handle ---the rib in lesion---become secondarily involved. Removal of the primary cause constitutes the only way in which legiti-

mate reduction of the secondary lesion may be accomplished. Occasionally both demand adjustive measures, particularly in the case of the chronic combined lesion where both conditions have become well stabilized.

When the vertebral lesion is primary the articulating ribs are secondarily malposed, but usually reduction of the spinal condition will automatically eliminate the costal, providing the rib involvement has not been of considerable duration and become sufficiently stabilized to demand adjustive measures.

Rib lesions are very troublesome and a source of considerable intercostal disturbance when present. Subjective visceral disorders may give a history which will tend to show a close association with, and relationship to, existing rib anomalies.

Lesions of the upper ribs are more apt to be expiratory and those of the lower ribs inspirational in character, while osteopathology of the intermediate ribs proportionately partakes of both types.

The causes of rib lesions are many and varied. Inherent dynamic forces of the body, such as muscular contractures, external dynamic forces such as trauma and adynamic forces such as gravity are all important in the etiological background. Faulty posture is an ever-present menace.

An Analysis of Objectives: An objective in this connection is that portion of the rib to which adjustive forces may be directed to the best mechanical advantage. In handling rib lesions it varies and is dependent upon the nature of the lesion. If we consider for the time a true bucket-handle lesion, we must recall that it has a double, fixed point axis, one fixed point posterior and the other anterior, and that the axis passes antero-posteriorly. In case of lesion it is natural to assume that both axes are involved and that both demand a certain amount of

Demonstrating lateral view of the normal spine showing the normal antero-posterior curves and the ribs in a depressed state.

adjustive force. It is practically impossible to direct adjustive forces upon both at the same time, therefore we must seek an intermediate point and maneuver in such manner as to effect adjustment on both axes by means of a force passing through the long axis of the shaft of the rib in both directions. The amplitude of motion of such an adjustive force is considerably greater than the range of motion which would be necessary at the fixed point axis to complete adjustment. If the rib is bisected it might then be asssumed that the same amount of force was necessary anteriorly as posteriorly. But also visualizing the fact that posteriorly there are two articulations as against but one anteriorly and also realizing the measurably great resistance offered by these two vertebral articulations, it is obvious that bisection of the rib does not give the desired point of attack. Therefore, after bisecting the rib it is necessary to then bisect the posterior portion or segment which will designate the angle. From a mechanical point of view this is the point of maximum mechanical advantage for the adjustment of the true bucket-handle type of lesion.

In the uncomplicated pump-handle lesion the desired point of attack is located midway between the costo-transverse and costo-central articulations. However, because of its situation in front of the transverse process it is impossible to utilize it. Therefore, we apply our adjustive force to a point as near the desired one as possible. In other words, the point of maximum mechanical advantage is located at the external portion of the rib just before it passes in front of the transverse process. For a matter of convenience the point of attack is termed the costo-transverse articulation.

In the combined pump and bucket-handle lesion the point of greatest mechanical efficiency is midway between the costo-transverse articulation and the angle of the rib. However, it is customary to combine both objectives by making the instrumentality of applied force of sufficient length to include both points.

Adjustive forces should be directed upward, forward and medialward, if the angle, the costo-transverse articular portion of the rib or the intermediate point, is down. If any one of these three points is up, then the adjustive force should be directed downward, forward and medialward.

Principles for Use of the Cervical Column in Rib Adjustment: When using the cervical column there are three principles of procedure which must always be employed: First, extension of the cervical column, because it anatomically locks the lower cervical segments and is a necessary factor in proper locking for protective purposes and moreover, because it adds and gives perfection to the possible use of a unit lever handle which would otherwise be defective if this primary movement were not carried out. Adjustment must never be attempted with the cervical spine in flexion. Second, side-bending to the side of lesion, to a degree sufficient to bring the vertex of the head directly over the rib in lesion so that when vertex pressure is brought into use the resultant force can pass through the costo-transverse articulation of the embarrassed costa. Third, reverse rotation, or rotation toward the side opposite that of lesion. This movement locks the upper cervical and adds efficiency to the resultant force by bringing the vertex into better mechanical position as well as by giving stabilization resistance at the point of lesion. The strain of the reverse rotation is greatest at that point.

To bring the first rib lesion into greater prominence, side-bend away from and rotate toward the side of lesion. This will tend to cause the transverse process of the first dorsal vertebra to rotate upward and backward and bring into greater relief the neck of the rib.

Circumduction is of no particular mechanical significance other than that it tends to superimpose soft tissue tensions which, in a measure, take up the slack in adjacent tissues and bring about an added stabilization resistance which makes adjustment somewhat easier.

The starting point of such a movement should be combined extension side-bending toward the side of lesion and it should sweep toward the opposite side, maintaining extension then be followed by flexion and by a carrying again across the midline in flexion; and from this point back into extension and to the starting point. Besides completing circumduction, the cervical column is then in a position of extension and side-bending. If rotation of the head to the opposite side is added thereunto all mechanical movements necessary to the stabilization of the cervical column have been completed.

When the patient is carried off balance, away from the side of lesion, the same thing has been accomplished as if the cervical column had been side-bent, providing the latter is maintained in the perpendicular plane. This allows the operator to work at better mechanical advantage and gives him greater additional resistive force to work against, as the patient's torso is so placed that it will take up the adjustive force more efficiently and with less yielding or buckling under it.

Adjustment of First and Second Rib Lesions:

Expirational Lesions. Technique No. 1. This method can be efficiently used for lesions of the first to fourth ribs, inclusive. Patient sits on the stool or table, and the operator stands behind him. Hypothetical lesion on the right side. If the patient is on the stool, the operator should place his left foot on the stool and flex the knee at right angles, then instruct the patient to lean toward the left side, with his axilla over that knee. If the patient is sitting on the table he should lean toward the left side against the operator's torso in such a manner as to be slightly off balance. The thumb of the operator's right hand is placed against the postero-superior aspect of the rib, adjacent to the costo-transverse articulation. His left hand is placed upon the vertex of the patient's head, and the arm along the

lateral aspect of the cervical column. The cervical column is circumducted and brought to rest in extension, right lateral flexion or side-bending and reverse rotation. Adjust at the end of expiration by combining downward pressure on the vertex of the head and a downward, forward thrust of the thumb on the rib.

Technique No. 2. This method can be used for the second to sixth ribs, inclusive. Patient prone. Reverse cervical procedure by extension, side-bending to the side opposite that of the lesion, reverse rotation, or rotation toward the side of lesion. Exaggerate cervical leverage. This tends through leverage action to bring the transverse process of the vertebra articulating with the rib in lesion upward and forward. Opposite this leverage force on the vertebra by counter force directed downward, forward and medialward against the postero-superior aspect of the rib adjacent to the costo-transverse articulation.

Technique No. 3. Patient supine; head and cervical column over the edge of the table. Extend the cervical column, side-bend toward the side of lesion and rotate the upper cervical spine away from the side of lesion. Vertex pressure with the operator's abdomen in such direction as to cause the resultant force to pass through the costo-transverse articulation of the rib in lesion. Adjustive force is applied downward, forward and medialward with the lateral aspect of the index finger. The palmar aspect of the opposite hand is placed along the lateral surface of the cervical column to stabilize and protect it.

Technique No. 4. First Rib Only. Patient supine, operator stands at the side of the table opposite that of lesion, facing the patient. The middle finger is placed against the rib and the palmar aspect of the opposite hand along the lateral aspect of the cervical column, on the side opposite that of lesion. This position of the hand allows the operator to hold the cervical column in extension, side-bending and re-

verse rotation. At the same time adjustive force is brought to bear upon the rib in lesion with the middle finger of the opposite hand. This same procedure may be utilized for the first rib with the patient sitting.

Inspirational Lesions: **Technique No. 1.** Patient sits on the stool or table and the operator stands behind. Hypothetical lesion on the right side. If the patient is on the stool, the operator should place his left foot on the stool and flex the knee at right angles and then instruct the patient to lean toward the left side with his axilla over that knee. If the patient is on the table he should lean toward the left side against the operator's torso in such a manner as to be slightly off balance with his body weight falling mostly upon the left ischial tuberosity. The thumb of the operator's right hand is placed against the postero-inferior aspect of the rib adjacent to the costo-transverse articulation. The operator's left hand is placed upon the vertex of the patient's head and the arm along the lateral aspect of the cervical column in such manner as to act in the nature of a splint for protective purposes. Circumduction of the cervical spine is carried out in the following order: Extension, left lateral extension; left lateral flexion, flexion, right lateral flexion, and right lateral extension. With the patient's neck in this position rotate the head so that the chin points toward the left shoulder. Adjust at the end of expiration by combining downward pressure on the vertex with an upward, forward thrust of the thumb.

Most of the above methods are effective for expirational lesions other than those of the first and second ribs.

Pump-Handle Lesions: (third to the sixth ribs, inclusive).

Inspirational Lesions **Technique No. 1.** Patient sits on the table; operator stands behind. Extends the dorsal column slightly, side-bends toward the side of lesion, and rotates toward the opposite side. Operator places axilla over the shoulder opposite that of the

lesioned side and passes forearm under axilla of patient on the side of lesion. The fingers which are free are interlocked with those of the opposite hand, the pisiform bone of which is placed against the postero-inferior aspect of the rib in lesion, adjacent to the costo-transverse articulation. Force is directed upward, forward, and medialward against the objective, while the torso is maintained and stabilized with sufficient extension, side-bending, and reverse rotation to maintain a physiological locking of that portion of the thoracic spine adjacent to the point at which rib adjustment is being effected.

Technique No. 2. Patient prone. The operator stands on the side of lesion, places his forearm under the axilla of that side in such manner that the fingers maintain firm hold on the shoulder-girdle. The pisiform bone of the opposite hand is placed against the postero-inferior aspect of the rib in lesion, adjacent to the costo-transverse articulation. Stabilizing the shoulder-girdle, the chest of the operator is brought to bear so that the additional force carries the hand maintaining the objective in a corrective direction.

Expirational Lesion

Technique No. 1. This procedure is exactly the same as that of technique No. 1 for the adjustment of an inspirational lesion, except that the objective is the postero-superior aspect of the rib adjacent to the costo-transverse articulation and that the corrective force is delivered downward, forward and medialward.

Technique No. 2. Patient supine, with arms folded across the chest so that the points of the elbows are brought more or less together in the median line and the hands are more or less in contact with the opposite shoulders. The patient is instructed to breathe deeply and at the completion of exhalation the operator brings downward and forward pressure to bear on the patient's elbows in such a manner that the resultant force passes obliquely antero-posteriorly

across the midline upward, backward and outward through the costo-transverse articulation of the rib in lesion. Opposing this is a parallel force which is directed downward, forward and medialward against the costo-transverse portion of the rib in lesion. The shearing action of these forces is such as first to break fixation, which may exist in the costo-transverse articulation, and force the neck of the rib to rotate downward and backward on its long axis. The operator's one hand is cupped over the point of one elbow and the other elbow is held in a fixed position with the axilla of the same arm. The other hand is placed underneath the patient in such manner that the elevated first phalanx of the thumb is in contact with the postero-superior aspect of the rib adjacent to the costo-transverse articulation. The hand underneath exerts counter force to the adjustive force passing downward through the arms and a secondary leverage force which is the result of muscle-tension.

Technique No. 3. Patient prone. This method is the same as technique No. 2 under inspirational lesions, with the exception that the pisiform bone is placed against the postero-superior aspect of the rib in lesion, adjacent to the costo-transverse articulation and the adjustive force is carried downward, forward and medialward.

Technique No. 4. Patient on his side, lesioned side uppermost, facing the operator. The operator's thumb is placed against the posterior portion of the angle of the rib. The lower border of the sterno-costal junction of the rib is maintained more or less fixed. The patient is instructed to inhale and exhale deeply, consonant with which the operator brings lateral pressure against the rib with his chest. At the beginning of inspiration the pressure is exerted downward and forward against the posterior extremity and upward and forward against the anterior extremity. The pressure should be maintained throughout, but accentuated during expiration. Springing the ribs in an antero-posterior direction and

directing the adjustive forces in the same manner as the above is an efficient manner of effecting reduction.

Combined Pump- and Bucket-Handle Lesion (third to sixth, inclusive).

These lesions are of a conjoint inspirational and expirational character and the methods of their reduction are similar to those which have been outlined, with but few exceptions. The objective is a little more lateral than that of the true pump-handle lesion. A very efficient maneuver is to join both objectives applicable to the true pump- and the true bucket-handle lesion. This can be accomplished easily by lengthening the distance of contact surface.

The Expirational Lesion:

Technique No. 1. The patient sits on the stool with the operator behind, either sitting on the table or standing. The hypothetical lesion is on the right side. The thumb of the operator's left hand is placed against the posterior portion of the angle of the rib. The operator then grasps the patient's right arm with his right hand so that the point of the patient's elbow rests in his palm, and the forearm of the latter is held at right angles to the arm. The patient is instructed to inhale, slowly and deeply, and, at the same time, the operator raises the shoulder-girdle by upward pressure against the patient's elbow, thereby creating tension of the following muscles: the rhomboidei, pectorales, trapezius, serratus anticus, and the latissimus dorsi. The operator then brings the elbow forward and medialward across the chest (the lower the lesion the greater the arc of movement). The arm is now raised above the patient's head, and the right hand and forearm of the patient are allowed to drop behind his neck so that the fingers touch the opposite shoulder, creating particular tension of the serratus anticus and the pectorales major and minor. The patient is now instructed to exhale. At the end of expiration the arm is allowed to drop to the desired point. This varies greatly. If the third rib, it should be on the level

with the shoulder; if lower, it should be allowed to fall posteriorly and inferiorly. The lower the rib, the lower and more posterior the point desired and the greater the sweep. The forearm is permitted to fall forward to the limit of its motion, causing rotation of the head of the humerus. The thumb of the left hand during this manipulation maintains upward, forward and medialward pressure against the lower border of the posterior portion of the angle of the rib.

The Inspirational Lesion: The same technique is used except that the manipulation is reversed. Inhalation is carried to a point where exhalation commenced in the former and exhalation commences where inhalation stopped. The pressure of the operator's thumb should be downward and forward against the upper border of the posterior portion of the angle of the rib.

The Bucket-Handle Lesion—Expirational Lesion: **Technique No. 1.** Patient supine, with hands folded behind the neck low down in the cervical column. The points of the elbows are brought more or less together in the median line. The patient is instructed to breathe deeply and at the completion of exhalation the operator brings downward and forward pressure to bear on the patient's elbows in such a way that the resultant force passes obliquely, antero-posteriorly across the midline, downward, backward, and outward through the costo-transverse articulation of the rib in lesion. Opposing this force is a parallel force which is directed upward, forward, and medialward against the angle of the rib in lesion. The shearing action of these forces breaks any fixation which may exist and forces the rib to retrace its pathway. The forearm of one hand is placed over the points of the elbows. The other hand is placed underneath the patient in such a way that the elevated first phalanx of the thumb is in contact with the postero-inferior aspect of the angle of the rib. The hand underneath exerts counter force to the adjustive force pass-

ing antero-posteriorly and a secondary leverage force which, in this particular case, is a direct aid to adjustive force as a result of muscle tension which tends to pull the rib upward at that point. These forces must vary according to the vertebra in lesion so that the resultant force will parallel to and pass in a shearing manner the adjustive force at all times.

Technique No. 2. Hypothetical lesion is on the right side. The patient lies on the left side. The fingers of the right hand of the operator are placed beneath the lower border of the angle of the rib, and the left hand is placed under the lower border of the sternal end of the rib. Simultaneously with deep inspiration, the arm is brought up and back (it is held between the right arm and the body of the operator during the manipulation), and strong upward pressure is directed against the rib with the fingers of both hands. Maintain firmly this position as the patient exhales.

Inspirational Lesion: **Technique No. 1.** Patient sitting on the table, the operator, standing behind, extends the dorsal column slightly, side-bends it toward the side of lesion and rotates it toward the opposite side. He the places his axilla over the shoulder of the patient on the side opposite that of lesion and passes his forearm under the axilla of the patient on the side of lesion. The fingers are thereupon interlocked and the pisiform bone of the opposite hand is placed against the postero-inferior aspect of the angle of the rib in lesion. The fingers are cupped underneath the inferior border of the shaft of that rib. A slight amount of traction is primary and is immediately followed by the application of adjustive force, upward, forward and medialward. The torso is supported and stabilized with extension, side-bending, and reverse rotation sufficiently to maintain a physiological locking of that portion of the thoracic spine at which the rib adjustment is being effected.

Technique No. 2. Patient prone. The operator places one hand, palmar aspect downward, against the transverse processes of the vertebra in the area of lesion, but on the side opposite that of the lesion. Maintaining this stabilization, adjustive force with the pisiform bone of the opposite hand is delivered, downward, forward and medialward, against the rib in lesion.

Lesions of the Eleventh and Twelfth Rib—Rib Elevated and Rotated on Its Long Axis:

Technique No. 1. In this lesion the rib sometimes has the appearance of being caught up under the tenth rib. The patient sits on the stool or the operating table with the operator standing behind. The hypothetical lesion is on the right side. The operator's left foot is placed on the stool and the leg flexed at right angles, or in the case of the table, the flexed leg rests on the table at the left side of the patient. The operator passes his left arm under the right arm of the patient and encircles the latter's body, his left hand grasping the left side of the torso. Lateral flexion and rotation to the left is made with the patient over the operator's flexed knee as a fulcrum, and at the same time the combined thumb and index finger of the adjusting hand is brought to bear against the superior border of the rib in lesion.

Rib Depressed and Rotated on Its Long Axis:

Technique No. 1. Rotation in this lesion is usually downward, so that the upper border is inverted and the lower border everted in contradistinction to the above lesion wherein the reverse is usually the case. Technique for adjustment may be the same as that used and described for the above lesion with the exception that instead of applying counter force against the superior border of the rib, the combined thumb and index finger, or such instrumentality as is most convenient to the operator, exerts an upward pull, or

adjustive force in a corrective manner. The posterior innominate is a frequent cause of this lesion as it many times results in the contracture of the quadratus lumborum muscle which secondarily pulls the rib into lesion.

Position for adjustment of the eleventh and twelfth ribs. Crosses indicate the position of the ribs. Adjustive force is applied to the rib through the agency of the thumb. Upper torso is the lever mechanism and the operator's flexed knee is the fulcrum over which the leverage action takes place.

Raising the Ribs: The same leverage forces are utilized in raising the ribs as were enumerated in technique No. 1 for the correction of combined pump- and bucket-handle lesions, particularly the pectorales major and minor, the serratus anticus and the external intercostals. Making a fulcrum or fixed point with the palms of the hands against the angles of the ribs, the patient is first instructed to inhale deeply and hold the breath until his arms can be elevated above the head. The active resistance of the patient is of decided value in this maneuver. In other words, the patient should slightly resist the operator's attempt to elevate the arms. By alternately raising and depressing the ribs the intra-thoracic pressure can be rapidly and forcibly changed, which in turn causes rapid shifts of intra-pulmonic pressures. This, of course, has a marked effect upon the respiratory capacity, in that alveolar ventilation is immediately and favorably influenced, particularly in such conditions as pneumonia, and the volume of oxygen increased proportionately. Its effect upon the circulation is also marked. As a means of avoiding passive congestion and congestive conditions within the lung tissue the effect of this maneuver is tremendous. It also increases respiratory capacity and, therefore, oxygenation. The cardio-respiratory mechanism is so closely correlated that in the normal state cardiac output varies directly with metabolism and alveolar ventilation.

In normal individuals, under exertion, the volume of alveolar ventilation and the volume of oxygen absorbed increase proportionately to a moderate degree. At levels in which the cardiac output is less than is theoretically demanded, the factors of safety inherent in the gaseous carrying power of the blood, increased venous pressure, due to increased vascular tonus as well as increased tone of other muscles, and the power of the body to super-ventilate the lungs are brought into play. When these added resources

can no longer take care of the increased demand, physical effort cannot be longer sustained.

There is no contraindication to raising the ribs. This is pulmonary tuberculosis, in which rest is the prime prerequisite of treatment. Postural rest in these cases is important, for a patient inspires one thousand times per hour; therefore the position that produces the least motion in the diseased area is indicated. As an early sign of tuberculosis Molle' refers to the pectoral and trapezius muscles as being particularly sensitive and contracted. Pain can be elicted if they are harshly palpated. Evidence of this pain can be noted by dilation of the pupil. Pottinger claims that in tuberculosis reflex disturbances of pupillary accommodation and of the gastric and cardiac mechanisms (through the vagus afferent fibers), are present. A slower rate of respiration is indicative of tuberculosis. Knoff instructs his patients to breathe slower as a hysiological adjuvant to treatment.

The Flat Dorsal: With the patient on the side the operator may apply lateral diagonal pressure to both sides of the thorax consonant with deep inspiration on the part of the patient. He can apply pressure with his chest against the upper side and maintain firm pressure against the lower side with his hands. This maneuver increases the antero-posterior diameter of the chest and tends to create mobility and uniform flexion in the dorsal area. The induction of increased mobility for the dorsal vertebrae and ribs is indicated in such conditions as costogenic anemia, diseases of the upper respiratory tract, such as bronchitis, asthma, laryngitis, rhinitis, etc. Relaxing the anterior chest muscles, especially the pectorales major and minor and the serratus anticus will promote lymphatic drainage with consequent systemic reaction and leukocytosis.

Doming the Diaphragm: By upward and lateral pressures against the lower ribs, especially the eleventh and twelfth, delivered simultaneously with forced expiration on the part of the patient, with the abdomen pulled in, the operator can dome the diaphragm. This movement is especially valuable in conditions in which it is desirable to decrease the intra-thoracic pressure and thereby secondarily influence drainage, either pulmonic or intra-thoracic. When utilized together with technique for raising the ribs, it is undoubtedly valuable for relief of intra-thoracic circulatory disturbances.

Fracture of the Ribs: The ribs are frequently broken, although they are able to withstand great force because of their yielding, spring-like action which gives them considerable immunity. The question of immobilization mechanically is one which demands consideration inasmuch as in the aged, the adynamic state of the ribs may lead to hypostatic congestion and this pneumonic condition in turn cause death. Certain authorities claim better results and greater freedom from complications if no attempt is made at fixation.

Cervical Ribs: Occasional supernumerary ribs exist. In the cervical area they are due to excessive development of the costal element of the seventh cervical vertebra. The condition is usually bilateral. It rarely produces symptoms until after the twentieth year. Usually there is only a superficial pulsation of the subclavian artery. A palpable prominence and evidence of pressure to the brachial plexus is symptomatic. Abnormally large transverse processes of the seventh cervical and adventitious ligaments may

simulate a cervical rib. Rib pressure may occasionally cause brachial plexus paralysis. This is more often found in the debilitated female following trauma and the pain is usually referred to the lowest cord of the brachial plexus (eighth cervical or first dorsal). Pain is usually referred to the inner side of the forearm in the character of tingling, numbness, feeling of pins and needles, coldness, etc. There may also be thermal anaesthesia, tactile impairment, motor weakness, or vasomotor changes.

Chapter XI.

FOOT SUBLUXATIONS

Applied Anatomy. The bones of the foot fall into three groups: the tarsus, the metatarsus, and the phalanges.

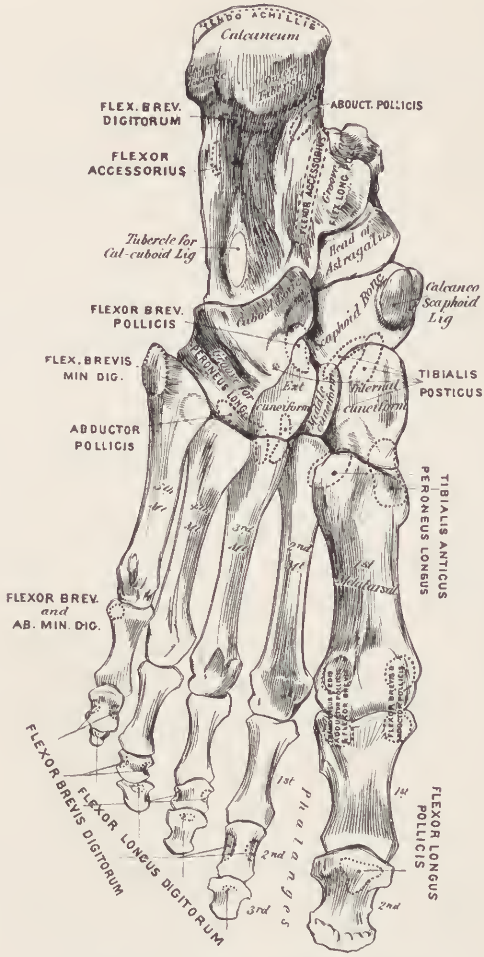
There are seven tarsal bones (ossa tarsi). They are the calcaneus, talus, cuboid, navicular, internal, middle, and external cuneiform.

The **calcaneous** or **os calcis** is the largest and strongest bone in the foot. It is elongated, projecting downward and backward to form the heel, serving to transmit the weight of the body to the ground and forming a strong lever for the muscles of the calf.

Its superior surface presents two articular surfaces for the talus which are separated by a groove for the talocalcaneal ligament; and internally a projecting process, the sustentaculum tali, for the calcaneo-cuboid ligament.

The inferior surface is rough and excavated and presents two tubercles, an outer and an inner, for muscles and ligaments. The internal surface is concave for passage of the tendons of the flexor hallucis longus and tibialis posticus, and plantar vessels and nerves.

The external surface presents a tubercle (processus trochlearis) for the external lateral ligament of the ankle and grooves for the peroneal tendons. The posterior surface, projecting behind, (tuber calcanei) presents a smooth surface above for a bursa and is rough below for attachment of the Achilles tendon and that of the plantaris. It articulates with the talus and cuboid. Its muscular attachments are tendo Achilles, tibialis posticus, abductor hallusis, abductor minimi digiti, flexor brevis, digitorum accessorius and extensor brevis digitorum.



The skeletal foot, plantar aspect.

The **talus** or **astragalus** is an irregular short bone consisting of a body (corpus tali), neck (collum tali), and head (caput tali). It supports the tibia above, rests on the calcaneus below, articulates on either side with the malleoli, and in front with the navicular.

Its quadrilateral body presents four articular surfaces; one above for lower extremity of tibia and the internal and external malleoli; two below for the os calcis, separated by a deep groove for the interosseous talocalcaneal ligament; posteriorly there is a deep groove (sulcus m. flexor hallucis

longus) for a tendon and anteriorly the rounded convex head supported by the neck articulates with the navicular ligament. Medially it presents a rough area for attachment of the deep deltoid ligament (internal lateral ligament of ankle). This bone has no muscular attachments. It articulates with four bones; tibia, fibula, navicular, and calcaneus.

The **Cuboid** or **os cuboideum**—is a small, pyramidal, cube-like bone situated between the os calcis and the fourth and fifth metatarsal bones on the outer side of the foot. The upper or dorsal surface is rough for ligamentous attachment, the lower or plantar surface is grooved for the tendon of peroneus longus, behind which is a ridge for the long calcaneo-cuboid ligament, terminating externally in the tuberosity of the cuboid (tuberositas ossis cuboidei). The external surface has a deep notch, the outer extremity of the peroneal groove. The posterior surface has a triangular facet for the calcaneus. The anterior two facets are separated by a ridge and are for the fourth and fifth metatarsals; and the internal surface has a broad facet for the external cuneiform and sometimes a small facet for the navicular. It articulates with four and sometimes five bones. It has one muscular attachment, part of the origin of the flexor hallucis brevis.

The navicular or **scaphoid** is a boat-shaped bone placed between the navicular and three cuneiform bones. The posterior concave surface articulates with the head of the talus. Its anterior convex surface has three facets for articulation with the cuneiform bones. Its internal border presents the tuberosity of the navicular and gives insertion for the tendon of the tibialis posticus which constitutes its only muscle attachment. Its other borders are roughened for ligamentous attachment. It articulates with the talus posteriorly and the three cuneiform bones anteriorly.

The cuneiform bones with respect to their position from within outward are the internal or first, middle or second, and external or third.

The Internal Cuneiform (first) is the largest. It has its base directed downward and its apex upward. It articulates anteriorly with the middle cuneiform and second metatarsal. The plantar surface presents a tuberosity for insertion of part of the tibialis posticus and anticus tendons.

The Middle Cuneiform (second) is the smallest. It has its base upward and its apex downward. It articulates posteriorly with the navicular, anteriorly with the second meta-

The skeletal foot, dorsal surface.

tarsal and laterally with the internal and external cuneiforms. It has no muscular attachments.

The External Cuneiform (third) is more regular in size and articulates posteriorly with the navicular; anteriorly with the third metatarsal; internally with the middle cuneiform and second metatarsal; and externally with the cuboid and fourth metatarsal. It gives attachment to the flexor brevis pollicis and tibialis posticus muscles.

The Metatarsal bones are five in number. Each consists of a head, a shaft, and a base. They are arranged in a nearly parallel manner. The shaft of each is curved, prismoid, concave below---convex above. Their heads are rounded for articulation with the proximal phalanges, have tubercles laterally for ligaments, and grooves inferiorly for the long flexor tendons. Their bases are wedge-shaped for articulation with the tarsus and with each other. They are numbered from within outward.

The First Metatarsal is the shortest, thickest and strongest. It articulates by its base with the internal cuneiform and second metatarsal, and by its head with the proximal phalanx of the great toe.

It gives attachments to the peroneus longus, tibialis anticus and the first dorsal interosseous.

The Second Metatarsal is wedged in by its base between the three cuneiforms and articulates with the proximal phalanx of the second toe and with the first and third metatarsals. The adductor hallucis and first and second interosseous muscles attach to it.

The Third Metatarsal articulates at its base with the external cuneiform, second and third metatarsals, and by its head with the contiguous phalanx of the third toe. It gives muscular attachments to the adductor hallucis, second and third dorsal and first plantar interossei.

The Fourth Metatarsal articulates at its base with the external cuneiform and cuboid and laterally with the third and fifth metatarsal and by its head with the first phalanx of the fourth toe. The adductor hallucis, third and fourth dorsal and second plantar interossei muscles attach to it.

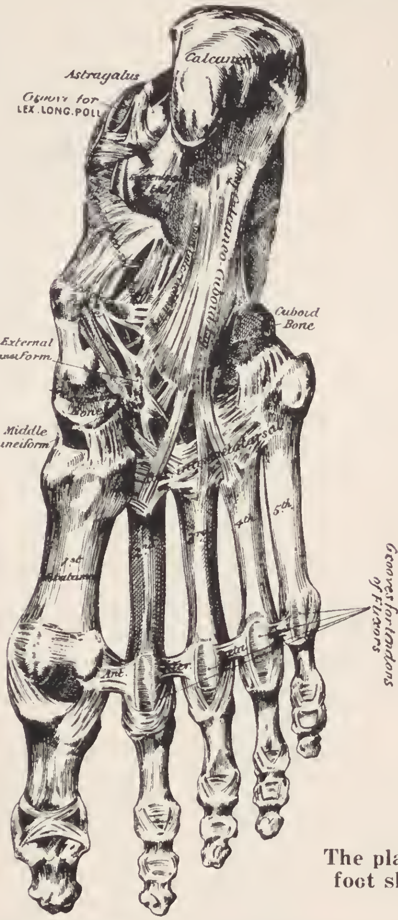
The Fifth Metatarsal has a well-marked tubercle on its outer side. It articulates with the cuboid, fourth metatarsal and fifth proximal phalanx, and gives attachment to the flexor brevis minimi digiti, peroneus brevis and tertius, fourth dorsal and third plantar interossei.

The **Phalanges, or Toe Bones,** are fourteen in number and are arranged in three rows. They consist of the first or proximal phalanges, and the second and third or distal phalanges. The second phalanx is absent in the big toe. Their muscular associations are numerous.

Sesamoid bones are small osseous masses independently developed in tendons to relieve pressure and for protection. One such bone is found in the tendon of the peroneus longus near its groove on the cuboid.

The ankle joint is a ginglymus or hinge joint, formed by the lower ends of the tibia and fibula and their malleoli, and the talus. Its synovial membrane is continued upward between the tibia and fibula for a short distance. It has four ligaments---

1. Anterior---connecting the anterior margins of the tibia and talus.
2. Posterior---a thin band of transverse fibers connecting the posterior margins of the tibia and talus.
3. Internal lateral or deltoid ligament (L. calcaneotibiale) from the internal malleolus to the three adjacent tarsal bones.
4. External lateral, consisting of an anterior fasciculus (L. talofibulare), a middle bundle (L. calcaneofibulare), and a posterior limb (L. talofibulare) which stretches from the external malleolus to the talus and os calcis.



The plantar surface of the foot showing ligaments.

The Tarsal articulations are connected by the following ligaments, viz.:

1. Talco-calcaneal — External, Internal, Posterior
2. Calcaneo-cuboid — Superior, Internal, Long, Short
3. Calcaneo-navicular — Superior, Inferior
4. Talo-navicular — Superior
5. Dorsal and Plantar.
6. Interosseous.

Movements of the Ankle Joint and Foot: The ankle joint is a ginglymus or hinge joint with rotation taking place about an oblique transverse axis. This allows the following movements:

1. Flexion: the normal position of the foot is at right angles to the body plane and the joint is therefore in a state of flexion at rest. Any movement which increases the degree of this angle is forced flexion.
2. Extension: likewise, any movement which tends to decrease the degree of this angle is extension.
3. Lateral Flexion: slight lateral movement is possible.

The foot allows of the following movements:

1. Plantar extension or dorsiflexion. This movement combined with extension of the toes causes a flattening or straightening of the plantar arch.
2. Plantar Flexion: This movement together with flexion of the toes exaggerates the concavity of the plantar arch.

Conjoint and Combined Movement of the Ankle Joint and Foot:

1. Pronation or Eversion.
2. Supination or Inversion.

Arches of the Foot: The foot is constructed in a series of arches formed by the tarsal and metatarsal bones, strengthened by ligaments and tendons, and constitutes a firm basis of support in the erect position with a minimum of effort. The bones are arranged in an elliptical arch, supported on two pillars, a posterior or calcaneal pillar and an anterior or metatarsal pillar.

Internal view of the right foot showing articulations and ligaments of the ankle, tarsus, and metatarsus.

The main arches are the antero-posterior arches which may be regarded as divisible into two segments---a medial and a lateral. The medial segment or arch is made up of the three metatarsal bones, the three cuneiforms, the navicular and the talus. Its summit is the superior articular surface of the talus. The lateral segment is made up of the fourth and fifth metatarsal bones, the cuboid, and the calcaneus. Both segments are supported posteriorly by a common calcaneal pillow. The summit of the lateral segment is the talo-calcaneal articulation.

Both longitudinal arches are intimately concerned with ordinary locomotion. The medial is characterized by its great curvature and elasticity and sustains the more violent concussions in jumping and similar actions. The lateral, less curved, more rigid, comparatively inelastic, forms with the common pillars a firm, base for support in the upright static posture. Its chief joint is the calcaneo-cuboid which possesses a special mechanism for locking, and allows only limited movement.

The joint most amenable to undue pressure is the talonavicular articulation. It is fortunately reinforced by the elastic plantar calcaneo-navicular ligament, which is able to respond quickly and restore the arch to its normal position when the causative force is removed. It is, moreover, strengthened by the blending of this supporting band with the deltoid ligament medially, and inferiorly by the tendon of the tibialis posterior which passes beneath the joint.

The **fundamental longitudinal arch** is made up of the calcaneus, cuboid, third cuneiform, and third metatarsal. They are so arranged that all the other bones of the foot might be removed without destroying this arch.

The foot is composed of a series of transverse arches. At the posterior part of the metatarsus and anterior part of the tarsus the arches are complete but in the middle of the tarsus they present the appearance of a sort of half-dome.

Fracture of the tarsal bones is unlikely because of the large number of articulating surfaces and the strong ligaments which serve to break the force of violence. Fracture of the neck of the talus or tuberosity of the calcaneus is usually produced by falls from a great height onto the feet. Fracture of the os calcis is rather common, comprising approximately 2% of all fractures, according to Straus. The posterior fragment of the os calcis is driven upward by the

impact at the time and maintained in this position by the constant tone of the Achilles tendon.

Skeletal foot, internal border.

Caries occasionally involves the bones of the feet, more especially the metatarsus, and particularly that of the big toe. The calcaneous and talus are sometimes affected.

Talipes (club foot) is a permanent congenital or acquired deviation of the foot into deformity.

Talipes Equinus is a persistant extension of the foot due to shortening of the Achilles tendon.

Talipes Calcaneus is a persistent flexion of the foot due to shortening of the flexors and lengthening of the tendo-Achilles.

Talipes Varus is a persistent adduction and inversion rarely met with and usually congenital.

Talipes Valgus is a persistent abduction and eversion usually met with in organic flat foot.

Certain of these deformities may be combined such as talipes equinovarus, talipes equinovalgus, talipes calcaneovarus and talipes calcaneovalgus. The causes of talipes are:

1. Congenital.
   (a) Persistance of fetal anomalies.
2. Acquired.
   (a) Nervous, through infantile paralysis, spastic contractures from cicatrices, traumatism, etc. Hysterical contractures.
   (b) Arrest of development.
   (c) Mechanical (intra-uterine pressure).

Congenital club foot should be treated in infancy when bones can be moulded as desired and held in restored position by means of plaster of Paris bandages. In severe cases section of the anterior and posterior tibial muscles, plantar fascia, tendo-Achilles, and long flexors of the toes will facilitate correction.

Pes Planus (flat foot) is a condition in which there is perversion of the arch of the foot, due to such factors as ligamentous and muscular weakening caused by prolonged strain of standing or trauma. Muscular paralysis sequent to rickets, overweight, improper shoeing, osteopathic lesions, etc. Da Costa mentions spurious flat foot, or inflammatory flat foot, which occurs in Pott's disease and in inflammations of the ankle joint, or of the tendon of the peroneus longus muscle, and paralytic flat foot following infantile paralysis.

Different classifications of flat feet are given. The common categories are enumerated below:

Oblique section of the articulations of the tarsus and metatarsus showing synovial membranes.

1. **Organic flat foot,** a condition of such sufficiently confirmed character that deformity of the foot is apparent and constant at all times and in all positions—for example: a foot which, when off or on the ground, shows an inner convexity at the talonavicular joint with abduction of the foot may be thus classified.

2. **Functional flat foot,** a condition not sufficiently confirmed to make deformity of the foot apparent and constant at all times and in all positions—for example: a foot

that looks normal when off the ground, but which shows an inner convexity of the talonavicular joint with abduction of the foot during weight-bearing. This is essentially a weak foot and its lesion is functional in character.

For convenience, flat feet may be divided into rigid and flexible types.

1. **Flexible flat foot** confirms its name. It is the ordinary relaxed, pronated foot and comprises a large proportion of all flat feet. A flexible flat foot may be functional or organic, depending upon its severity. It is very amenable to corrective exercise.

2. **Rigid flat foot** is an acutely stiff, painful and pronated foot. Rigid flat foot can be made flexible by manipulative measures.

Another classification much in use is as follows:

1. **First degree flat foot;** a mild degree of perversion in which one or more of the three arches are involved but not sufficiently to be classified as

2. **Second degree flat foot,** which is a more severe condition resulting from one or more of the three major arches being involved to the extent that they are comparatively flattened out and so that the weight-bearing foot touches at several points foreign to weight-bearing; and

3. **Third degree flat foot,** in which one or more of the three major arches are involved so extensively that they are not only flattened out but may, in a sense, become acutely inverted.

Static flat foot is a term applied to certain types of pedal osteopathology. This type is particularly noticeable when the patient is standing and is usually due to disproportion between body weight and provisions for the support of that weight. It must be recognized that in certain cases a static flat foot may be a fully functionating foot, free from pain

and disability, as, for example, the aboriginal foot, which is extremely flat when subject is standing; but immediately upon activity it becomes arched. A foot that has a low arch, but which is able to flex or grasp (prehensile function) and which under weight-bearing does not abduct, is comparatively normal.

All children are born with pronated feet and the arches usually begin to form soon after birth, but sometimes never develop. So-called congenital flat feet are thereby produced.

An imaginary straight line continued downward from the center of the leg would pass anterior and internal to the greater portion of the talus and calcaneus; hence body-weight presses on the inner side of the foot and normally tends to flatten the arch and cause outward rotation. This tendency is opposed by the action of the flexors of the toes and by the tibialis posticus muscle.

A pronounced flat foot can be easily recognized by wetting the sole of the patient's foot with a colored solution and instructing him to step firmly upon a white paper. Careful observation of the inner surface will detect slight cases when the patient is instructed to place weight upon the foot. The inner surface will descend as the arch falls. The Golding-Bird method of measurement is a very accurate way by which to determine the presence and extent of flat foot. The point of articulation of the internal cuneiform and the metatarsal bone of the great toe is taken as the middle of the normal foot. In flat foot, the greatest change is in the posterior half of the line. The extent to which the posterior measurement exceeds the anterior is the degree of flat foot. It rarely exceeds three-fourths of an inch.

Pain in flat feet is such that the patient complains of marked discomfort in the region of the ball of the toes when walking. Pain is immediately decreased if the individual removes shoes and relieves the foot from weight-bearing. Palpation of the metatarso-phalangeal articulations between

two fingers will elicit considerable pressure pain. This pain is possibly due to irritation of the nerve terminals of the joints, particularly the articular branches of the anterior tibial, brought about by an overstretching of ligaments and a consequent tension of and around the nerve terminals. Permanent relief consists in correcting the arch difficulty so that weight on the ball of the foot may be shifted back to the middle of the foot.

Contracture of the Achilles tendon in children is seldom recognized if slight; but in the adult, long periods of standing will precipitate acute symptoms of flat foot. It is more an acute plantar strain than an obvious tarsal disorder. One significant thing, however, in this connection is the pronounced flattening of the anterior longitudinal arch with marked extension of the phalanges. The tarsal lesions are usually confined to the middle and external cuneiform and the cuboid. Walking on the toes is painful, due, probably, to the fact that the toes are usually in a state of chronic extension on account of the condition of the anterior arch. Pain is quickly alleviated by sitting down. Any contracture of the Achilles tendon demands a slightly higher heel than is customarily worn.

The Use of Heels: Although a sacrifice of stability is entailed, there is a compensatory economy of energy in locomotion. Their basal area should always be large. For practical purposes, a heel should be from one to one and a half inches in height, as it permits of active use of calf muscles, does not throw weight too far forward and yet takes off considerable strain in walking. French or Louis heels are very impractical on account of mechanical curve and lack of support. Cuban heels are the best.

Children require little height of heel; men slightly more; and women a still greater amount. This is due to the fact that corsets and skirts prevent freedom of movement of the

hips and therefore more action of the foot is demanded. Strain of the long arch is proportionately less as the height of the heel increases. The height of a heel for remedial purposes should not exceed two and one-half inches and houseshoes not less than one and one-quarter inches. Slippers, sneakers and moccasins should be avoided.

Shoes should not be too narrow across the toes but should fit snugly behind the ball of the foot and maintain a good, firm grip on the instep. Thin and unyielding insteps, which bulge and break down after a few weeks' wear, are injurious.

In walking, avoid lurching and dipping (economy of effort) and use both flexors and extensors alternately and fully. Place the whole foot, heel, ball and toes down together, and do not rest too much weight on the anterior portion of foot.

The Mechanism of So-Called Flat Foot:

Grouping No. 1. The weakest part of the foot is mid-tarsal or at the talo-navicular and calcaneo-cuboid articulations. The strain of muscle pull and leverage relaxes these joints, muscle balance is unequal and broken, and abductors and extensors do not function coordinately with abductors and flexors. The fore-foot everts and pronates, causing the navicular to rotate on an antero-posterior axis about the head of the talus. As the fore-foot abducts and rotates the static leverage force of super-imposed body weight through the perpendicular plane is apparent and acts in such manner as to evert the tuberosity of the calcaneous and by means of that fulcrum to pry the bone farther from the perpendicular plane in which it is normally carried. Therefore, as the mesial border of the foot pronates and everts the tuberosity of the calcaneus turns out and the head of the talus dips down toward the plantar surface with mesial tilting. The mesial dipping of the head of the talus is more prominent as that portion of the talus describes the greater range of motion. The security of the anchorage of the talus

between the malleoli, fortified by short, strong ligaments and no musculature, prevents any very pronounced internal-lateral subluxation.

The navicular in this case moves in a peculiar manner. Due to a spreading of the arch, a certain amount of arthrodial slipping is expected medialward and downward at the arch and as it is a distal portion of the fore-foot, rotation is expected. This rotation, however, because of resultant forces, is conducted in such a manner as to cause the medial segment to rotate upward and the external segment to rotate downward; the latter describing a considerably greater arc of motion. The medial border (tuberosity) of the navicular is very prominent medially.

The internal cuneiform slides downward and medialward. Secondarily a ptosed position of the cuboid often ensues, the mechanical reason for which is not clear unless it be in the character of a buckling strain.

The first, second and third cuneiforms are conjointly involved with the navicular and also assume a ptosed position. This is productive of a flattened transverse arch at this point and is further aggravated by same. All three cuneiforms in turn create more distal mechanical anomalies as follows:

(1) The proximal end of the metatarsal is elevated by the corresponding drop of the adjacent cuneiform. The distal end of this long bone is depressed as the transverse axis of motion passes through at an intermediate point midway of the shaft. This allows for an over-riding of the distal end of the metatarsal by the phalanx articulating with it.

Hallux valgus is a possible resultant as the influence of body weight and the peculiar leverage force of this pronated foot acts at such an angle as to pry the phalangeal portion of the first metatarso-phalangeal articulation laterally.

The fibula often rotates upon its long axis with its spatulate malleolar extremity directed along a backward arc

with concomitant rotation of the head backward and medialward. This force tends to act as a pry and separates the malleoli. (Comparative measurements will elicit this finding.) As a result of this indirect strain and the oblique plane of the articular surface of the talus, genu valgum is possible.

Grouping II. (Very common but seldom recognized.)

Muscle coordination is so unbalanced that the adductors and supinators dominate the abductors and pronators. This is possibly a sequence of frequently sprained ankles in which the deltoid ligament has become unduly weakened or in those cases wherein factors which tend to allow the perpendicular plane of body weight to pass lateral to its normal position are apparent, as in the case of excessive static strain of prolonged standing, over-weight, etc. Individuals thus affected usually walk on the lateral aspect of their feet and frequently toe-in to an exaggerated degree. They often complain of unduly weak ankles which have a tendency to turn frequently. Their shoes are badly run over on the outer side and they are unable to stand any length of time with comfort.

The tuberosity of the calcaneous is inverted and this acts as a pry and forces the cuboid to assume a ptosed position in the lateral arch. Besides separative strain on the calcaneo-cuboid articulation, excessive static strain on the cuboid follows as a natural sequence to the position assumed. The lateral arch receives more than its usual burden at an oblique angle and there is a tendency for the entire outer segment to become weakened, although the cuboid is the main offender.

The talus, en masse, assumes a more externo-lateral position with a slight tilting at a different inclination.

The fibula is apt to rotate on its long axis, and its spatulate malleolar extremity along a forward arc with a tendency of the head to rotate outward, and anteriorly. The third and fourth metatarsals, which articulate with the cuboid, are likewise involved in a manner similar to that previously described under grouping No. 1.

Grouping III. A condition in which both longitudinal arches are involved to a greater or lesser degree. In other words, an implication of the fundamental longitudinal arch in which there is a spreading of the transverse arches with the virtual ptosis of the whole foot.

It must be kept in mind that not all of the conditions mentioned in these groupings are consistently found. But their tendencies are constant. Other factors may creep in, in which event other findings will manifest themselves. We must, therefore, bear in mind the typical lesion and also be on guard continually against the atypical.

The Individual Lesion and Its Adjustment: Practically all adjustments, with the exception of some general maneuvers, are directed to the bone in lesion.

Subluxation of the Calcaneus. This is part of a composite lesion involving the talus (talo-navicular articulation) and adjustment has the double purpose of correcting positionally both bones at the same time with one procedure. Two types of lesions are found:

1. A condition previously suggested in Grouping I, in which the medial longitudinal arch is involved with eversion of the tuberosity of the calcaneus and the medial tilting and subluxation of the talus. The objectives, or the points through which the greatest corrective force may be applied in this case are the postero-lateral aspect of the heel and the mesial aspect of the head of the talus. Simultaneous force should be directed in a doubly transverse manner in opposite directions and with the foot under traction---that against the talus transverse laterally, and the calcaneus transverse mesially.

2. A type included in grouping II, in which the lateral longitudinal arch is involved with inversion of the tuberosity of the calcaneus, and lateral tilting and subluxation of the talus. The objectives in this case are the postero-medial aspect of heel and the lateral aspect of the head of the talus.

Simultaneous force should be directed in a doubly transverse manner in opposite directions with the foot under traction: that against the talus transverse mesially, and that against the calcaneus transverse laterally.

The Talotibial Articulation: This is represented by a full range of motion under traction and completed with an exaggeration of traction—a quick, snappy pull. Minor subluxations and conditions in the ankle joint itself are amenable to this treatment. It is a general method and not designed to meet anything but a general need.

Subluxation of the Cuboid: The cuboid bone is one of the most frequent offenders in the foot. It is second only to the combined lesion of the middle and external cuneiforms. Marked sensitiveness can be elicited upon pressure, together with palpatory findings which indicate that the bone is in a ptosed position. Its constant association with lateral arch conditions is pathognomonic.

The objective should be the plantar aspect of the bone. The corrective force should be directed upward and medialward with the patient supine. Leverage force is acquired by flexing, abducting and pronating the forefoot. The instrumentality of force is the flexed index finger, reinforced by fingers of the opposite hand. Counter force should be applied to the proximal end of the metatarsal by thumb pressure of the adjusting hand. The opposite hand controls leverage force.

The above method is best and most universally effectual.

Another maneuver is to place a firm, hard, small pillow over the knee or thumb over the knee cup, hold firmly the heel and the dorsal surface of the foot, and with the foot in an abducted, pronated position, to bring the bone in question over the reinforced, flexed knee as a fulcrum. Other methods have been devised and used by the author when these meth-

ods have failed, but the above have proven the most effective in the largest number of cases.

Subluxation of the Internal Cuneiform: This is probably third in relative pathologic importance and frequency. It is common in Grouping I and in cases having a tendency toward hallux valgus. Sensitiveness and palpatory findings make diagnosis easy. Adjustment of this condition can best be effected by laying the patient on the side lesioned with the foot uppermost. Place a firm, hard pillow at the edge of the table, beneath the foot in such a manner that the lesioned articulation is at the edge of the cushion. Place index and second finger against the objective, which is the plantar aspect of the cuneiform, and rest heel of the hand on the lateral aspect of the ankle joint for fixation and protection. The forefoot should be flexed, adduction and spinated. This is leverage force and is controlled by the opposite hand. Exaggeration of leverage force with strong pressure against cuneiform in an upward direction completes adjustment.

The internal cuneiform articulating with the first metatarsal and navicular can be handled by this technique. If both joints are involved the objective should be intermediate. If the proximal articulation, then the objective should be nearer the joint involved (articulation with navicular); if the distal articulation, the objective should be nearer the articulation with the metatarsal.

Subluxation of the Navicular: The same leverage principle is applied as is used in making the adjustment of the internal cuneiform, excepting that different points of fixation are maintained, so that leverage force will be delivered against the navicular only. A slightly greater element of rotation is made use of in both leverage and corrective forces, so adjustment of this lesion describes quite an arc of rotation around the head of the talus.

Subluxation of Middle and External Cuneiforms: These are considered as one lesion as they are so intimately associated in the conjoint lesion movement. For all practical purposes then, they can be considered together. Moreover, because of their small surface area, both can be adjusted at the same time and with the same movement. In fact, it would be a superhuman feat to maintain a small enough surface contact to adjust one without adjusting its fellow.

Technique I: Patient prone, grasp the foot in such a way that the interlocked fingers maintain a counter force against the dorsal aspect of the proximal ends of the metatarsals, particularly the second and third. Corrective force is made through the instrumentality of the thumbs, one reinforcing its fellow. Exaggerate flexion of the foot (plantar aspect) making the apex of this angle the point of lesion; then, with still further stress, direct a simultaneous force against the plantar aspect of the cuneiforms, with increased pressure of the thumbs and proportionate counter pressure.

Technique II: Patient prone, flex knee to right angle, grasp foot in such a manner that the heel of one hand rests against the postero-inferior aspect of the tuberosity of the calcaneus and the heel of the opposite hand rests against the distal ends of the metatarsals (toes must be in extended position). With this purchase, attempt to approximate heels of hands. This will cause the arch to buckle and give the operator the opportunity---with firm pressure on the cuneiforms with the tips of the index and second fingers and slight flexion---to force bones back into proper position in the arch.

Technique III: Patient prone, so that forefoot is over the edge of the table. Place the adjustment pillow on the edge of the table, rest the forefoot over it in such a manner as to bring counter force against the dorsal aspect

Position of the foot for adjustment of a subluxation of a fourth metatarso-phalangeal articulation. Arrow C indicates direction of traction flexion leverage force. Arrow B points out head of the metatarsal against which adjustive force is directed. A indicates proximal extremity of metatarsal against which counter force is directed.

of the proximal ends of the metatarsals. The pisiform bone is the instrumentality through which corrective force is given. Force is directed against the plantar aspect of the cuneiforms. The applied force is the thrust, one hand reinforcing the other.

Subluxation of the Metatarsals: Reference is made in this case to the subluxations of the phalangeal-metatarsal articulations. These lesions are in exact correlation with lesions of the tarsal bones with which they articulate. In other words a lesion of the cuboid is usually accompanied by a secondary lesion of the fourth and fifth metatarsals, internal cuneiform, first metatarsal; middle cuneiform, second metatarsal; and third cuneiform, third metatarsal.

The phalangeal metatarsal lesion evinces a tendency for the proximal end of the phalanx to over-ride the distal end of the metatarsal. Here is a tilting of the metatarsal, distal end down, proximal end up, together with a ptosed position of the adjacent articulating tarsal bone. The toes are held in a chronic, extended position.

Technique: Adjustment can best be carried out with the patient supine. Operator places the apex of the flexed index finger against the plantar aspect of the distal end of the metatarsal and the flexed thumb of same hand over the dorsal aspect of the phalanx. Support of the foot and counter force for the metatarsal is accomplished by grasping the forefoot with opposite hand in such manner as to bring strong dorsal pressure against the proximal end of the metatarsals. Leverage force is controlled by action of thumb against the phalanx. It consists of traction and flexion and at the moment of adjustment exaggeration of traction and flexion with strong corrective force against the distal end of the metatarsal with the flexed index finger.

Using these same principles, adjustment can be made with the patient prone.

General Unclassified Measures for Varying Foot Conditions:

1. **The general method for rigid flat foot:** The purpose of this technique is not specific adjustment, but rather a general method for freeing up a large number of articulations. It is as follows:

The foot is grasped in the two hands, one holding the tuberosity of the calcaneum firmly under traction, the other grips the forefoot firmly, palm over the dorsum of the foot. Quick simultaneous exaggeration of traction with the hand holding the tuberosity of the calcaneus, together with strong flexion and adduction of the forefoot will usually break up a rigid condition of the longitudinal arches.

2. **Stretching the Achilles Tendon:**

With patient supine on the table, grip the tuberosity of the calcaneus firmly with both hands. Place apex of the flexed knee against plantar aspect of the distal ends of the metatarsals. Strong traction with the hands and pressure with the knee will serve to produce a marked stretching of the tendon.

Extremely stiff Metacarpophalangeal joints can be gradually flexed with plaster and by the means of the so-called "retaining splint." This flexion is maintained and can be increased from time to time. The joints should be given passive movement and massage at stated intervals. When they can flex voluntarily and retain this flexion, treatment is completed.

Electrical treatment of foot musculature is sometimes beneficial, preliminary to voluntary exercise, for atonic and relaxed, pronated feet.

Ankle joint injuries should be treated in such manner as to get rid of the effusion which separates the torn ends of tissues and immobilized in such a fashion as to prevent any movement which will stretch or tear newly repaired tissues and thus make conditions chronic. Apply a pad of adhesive plaster over the effusion and a similar pad over the tendon im-

mediately above the inflamed area. This done, a bandage should be applied. Encourage free blood supply by massage, contrasted needle-spray baths, or hot and cold compresses.

Adjustment of the Fibula: Minor subluxations of this bone, as previously mentioned, are very common with allied foot conditions. They consist of rotations of the shaft of the fibula on its long axis. In the type associated with Grouping I the rotation is along an arc directed backward and medialward. In Grouping II the bone revolves upon an arc directed forward and outward. In both cases there is partial immobilization, particularly at the head. Corrective procedures must bring into play a full range of rotary movement, particularly at the head of the bone. The following procedure may be utilized:

Technique: Patient seated, knee flexed, leg and foot abducted and everted. Using the foot as a lever with one hand, strong extension and eversion are used. With the other hand, operator maintains firm counter force and adjustive tension against the postero-lateral aspect of the head of the fibula. This partially corrects the lesion, carrying the bone to its anatomic limit in a postero-medial arc. Counter force at this point is adjustive. Carrying the foot into strong extension and inversion, pressure of the adjusting hand shifts to the antero-lateral aspect of the head of the fibula where it maintains both counter and corrective forces. From the previous position, the foot is quickly everted and knee extended, with increased pressure of the adjusting hand at the same moment. This completes the adjustment by carrying the bone as far as it will go in an antero-lateral arc. Counter force at this point is adjustive.

This complete procedure is corrective in inverse order for both Group I and Group II conditions and this same inverse action corrects the malleolar articulation inversely to the head, so that at completion both extremities are normalized.

Position taken for adjustment of the fibula immobilized in either forward or backward rotation on its long axis. Arrows A and B indicate combined objectives anterior and posterior to the head of the fibula. The leverage mechanism is largely controlled by the action of the foot which is carried in the direction indicated by the arrows E and D.

Dislocation of the Fibula at the superior tibiofibular articulation is due to extremely violent adduction of the foot with abduction of the knee, occasionally by direct force. The head of the fibula may be forward or backward. The knee is held in semi-flexion with limitation and impairment of both flexion and extension. There is a depression where the head is normally found. Continuation of the fibula superiorly will end in movable projection.

Adjustment: Bend knee to relax biceps, and push bone into proper position. Place a compress over the head of the bone, bandage and place the limb in a position of easy double flexion (knee and thigh). A lacing knee support at the end of several weeks will hold the bone in position.

Dislocation of Ankle Joint: This condition is not infrequent. It may be complete or incomplete.

Lateral Dislocation inward and outward with rotation of the astragalus. It is caused by twisting of the joint and the foot presents a lateral twist or outward dislocation, associated with Pott's or Dupuytrin's fracture. Flex leg on thigh, or thigh on pelvis, counter extension from the knee, extension from foot, rocking the talus into place. Complete treatment by use of the fracture box.

Dislocation upward or Nelaton's dislocation is rare. The talus is wedged between the widely separated tibia and fibula. It is caused by a fall upon the feet from a great height.

Symptoms: Widening of ankle joint and flattening of the foot. Absolute rigidity. Malleoli on level with plantar surface of foot. The treatment is extension and counter extension.

Antero-posterior dislocation of the joint is rare, produced usually by catching the foot in jumping or falling—direct violence. Forward dislocation, the foot is lengthened, heel

inconspicuous, tibia and fibula project against tendo Achilles. Dislocation backward: the foot is shortened, tibia and fibula project forward, heel is prominent.

Treatment as in lateral dislocation: plaster of Paris dressing.

Dislocation of Talus: may be separated from bones of the leg and at the same time those of tarsus.

Antero posterior dislocation is caused by falls or twists.

Symptoms:

> Forward dislocation; the talus projects strongly; shortening of foot; malleoli approach plantar aspect, foot deviated; absolute rigidity.

Backward Dislocation: No deviation of foot, bone projects between malleoli and above calcaneus, and tendo Achilles is stretched over projection. Absolute rigidity.

Lateral and Rotary Dislocations of Talus are rare, and associated with fracture.

Rotary Dislocation. Talus remains in its normal habitat, but rotates on either its own horizontal or vertical axis. This lesion is caused by a twist of the foot when at right angles to the leg.

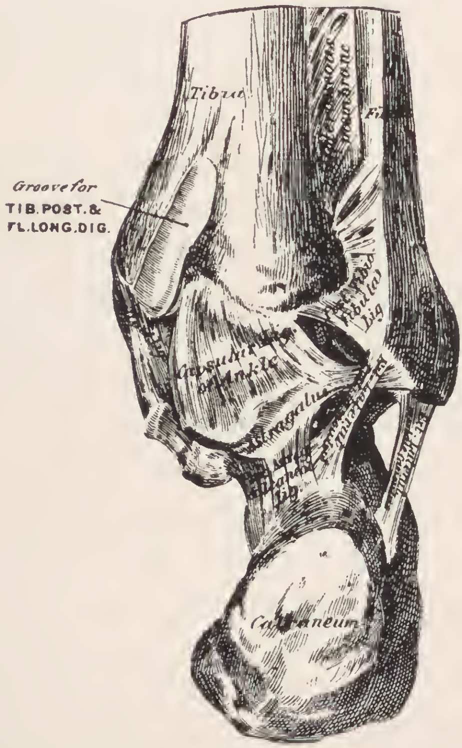
Symptoms: Rigidity.

Treatment: Flex knee to relax gastrocnemius, extend foot, and push bone into place.

Subastragaloid Dislocation. Separation of talus from os calcis and scaphoid without separation from bones of leg. Dislocations are forward, backward, inward, and outward. The cause is twisting. The talus projects on the dorsum of foot; foot is everted outward; dislocation inverted inward. The foot is shortened in front, and lengthened behind; ankle joint is unaltered and not absolutely rigid.

Treatment: Make extension in direction opposite to that of displacement (forefoot). Counter extension (hindfoot). Plaster of Paris dressing.

Pes Cavus (Hollow Foot)



Posterior view of the ankle joint with ligaments.

Increase in the arch of the foot, due possibly to hypotonic state of peronei muscles. Adductors act unopposed and secondary contraction of the plantar fascia follows. Wearing too short a shoe resulting in pressure on the toes, with resultant spasm of plantar flexors. This condition can sometimes be overcome by wearing a shoe sufficiently long with a steel shank in sole and attached strapping over instep.

Hallux Varus and Valgus: Displacement of great toe, respectively, inward (varus) or outward (valgus). It is frequently encountered in elderly people, particularly women. Wearing pointed shoes, shoes too short or extremely high heels may predispose. Gout, rheumatism, and allied rheumatoid arthritis is provocative. In hallux valgus, bunion (bursitis) is apt to form over metatarsophalangeal joint. Exostosis at the distal end of metatarsal bone is frequent.

Hammer Toe: Flexion of one or more toes at the first interphalangeal joint due to contraction of the plantar fibers of the lateral ligaments of the joints. It usually begins in youth and may be congenital. Callous formations develop at pressure point and joint may be dislocated. Subcutaneous divisions of the lateral ligaments and flexor tendon or amputation is sometimes the only means of relief.

Metatarsalgia: (Morton's disease). This is a painful condition due to jamming of the nerve between the heads of fourth and fifth metatarsal bones. The head of the fifth, by lateral pressure, is forced against and below the neck of the fourth with the result that the superficial branch of the external plantar nerve and its branches are impinged. It is usually associated with flattening of the anterior arch. Loss of this arch may jam other nerves than those mentioned, with similar symptomatology.

Retro-Calcanean (Achillo-Bursitis): This is an inflammation of the bursa lying between the insertion of the Achilles tendon and the tuberosity of the os calcis. Effusion sometimes occurs. The causative factors are as follows:

1. Functional---over use of the feet.
2. Traumatic---pressure of improper shoeing.
3. Bacterial---tuberculosis, gonorrhea, rheumatic infections, etc.

Pain is localized at the junction of the Achilles tendon and the os calcis. Pain is greater on motion; rest alleviates. The foot is more comfortable when everted and the leg rotated outward. Tenderness and occasionally a doughy mass can be palpated on each side of the Achilles tendon. This condition is responsible for the associated pain in the tendon (Achillodynia).

CHAPTER XII.

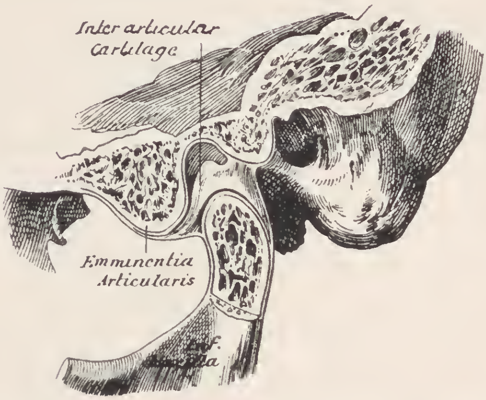
LUXATIONS, PARTIAL AND COMPLETE

Forward Luxation of the Mandible: This condition is usually caused by muscular action such as yawning, laughing, crying, etc. It may be the result of forcible attempts to introduce a large object into the mouth or of direct violence.

The synovial membrane has a very strong outer sheath which is known as the external lateral ligament. The internal lateral ligament is not in immediate contact with the joint but extends from the spinous process of the sphenoid bone to the inferior dental foramen and by another portion known as the stylo-mandibular ligament from the styloid process of the temporal bone to the posterior border of the ramus of the mandible. The joint contains an inter-articular cartilage or meniscus which overlaps the upper surface of the condyle and accompanies it in its normal movement forward from the glenoid cavity to the eminentia articularis when the mouth is opened. The surface of the eminentia articularis is inclined slightly upward to become continuous with the narrower, lower surface of the zygoma.

The chief movement of the joint is ginglymoid, acting in the nature of a hinge and accompanied by slight gliding movement when the mouth is opened or closed. When the mouth is opened, the condyle describes a hinge-like movement on the fibro-cartilage; at the same time the fibro-cartilage, together with the condyle, glides forward. If the condyle slips over the summit of the articular eminence, it slips into the zygomatic fossa, and the mandible is dislocated. In the closing movement the condyle revolves backward and the fibro-cartilage glides back, carrying the former with it. The horizontal gliding action by which the lower jaw is thrust forward and back again takes place in the outer compartment between the fibro-cartilage with the squama of the temporal

bone. In the above types of movement the joints of both sides act simultaneously and similarly.



Vertical section of the temporomandibular articulation.

A third type of movement is oblique and rotatory. This consists of a rotation in which the condyle revolves around the vertical axis of its neck. Such movement is confined to the lower compartment between the fibro-cartilage and the condyle itself. At the same time, the fibro-cartilage glides obliquely forward and inward on one side, and backward and inward on the other—each side acting alternately. The axis of motion shifts accordingly from one side to the other as the arc of motion reverses its direction. In the ordinary grinding movement, one condyle advances and the other recedes, and vice versa—slight rotation taking place in each one, meanwhile. The axis of motion, therefore, in this movement, shifts from one condyle to its opposite fellow. A unilateral axis is possible, passing in an obliquely vertical direction through the long axis of the neck. In such a case the condyle revolves on this axis without an antero-posterior shift, allowing the opposite condyle and cartilage to glide forward and inward upon the glenoid fossa.

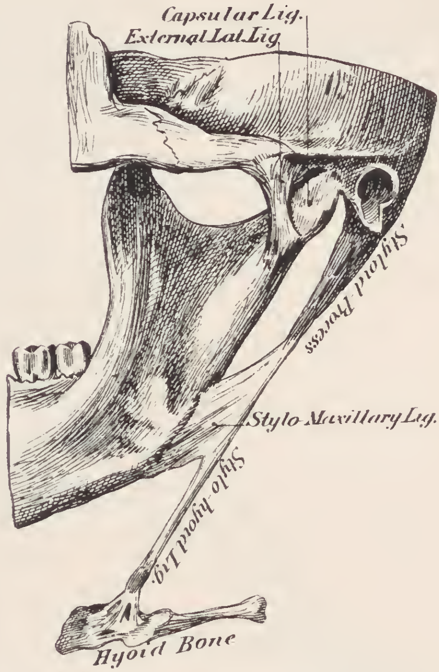
The muscles which close the mouth are attached to the ramus and extend upward and forward with the exception of the deep posterior fibers of the masseter, which are vertical or inclined backward.

Due to the fact that the condyle moves forward when the chin descends, the center of motion of the jaw is not in the condyle, but at a point below and in front of it, in the region of the dental foramen. The angle of the mandible moves backward at the same time and consequently the ramus of the jaw noticeably shifts its relationship to the direction of the fibers of the masseter. This shift in the axis of the ramus brings the line of the posterior fibers behind the center of motion where their contraction tends to open the mouth, or keep it open.

If the condyle advances beyond a normal point on the articular eminence, it may become fixed. If the reason for this fixation is muscular it is usually due to contracture of the external pterygoid and posterior fibers of the masseter aided by relaxation of the external lateral ligament.

Occasionally the capsule may be ruptured. The coronoid process may also become engaged beneath the malar bone and act as an accessory cause to fixation. The meniscus, if torn, may be an additional partial factor in fixation and render complete reduction manually impossible.

The external lateral ligament, which forms the anterior, outer portion of the capsule, stretches from the articular eminence downward and backward to the neck of the condyle. This ligament is too short to remain in such a position when the condyle is dislocated, nor can the long axis of the neck coincide with that of the ligament. When the mouth is opened widely, therefore, the ligament relaxes as the condyle passes forward so that the neck is bisected by the long axis of the ligament with the condyle anterior. When the mouth is partially closed, the ligament becomes tense and if the condyle does not move past the point of the upper attachment of this ligament, before tension becomes too great, further movement backward is prevented by this mechanism. Any attempt to close the mouth merely further aggravates the tension of these ligaments and the associated powerful muscles of mastication.



External view of the temporomandibular articulation.

When the dislocation is unilateral, it is usually due to a violent shunting of the jaw forward when the mouth is open. Biting on a hard, round comparatively large object may be a sufficient fulcrum to act more or less as a rolling skid, shunting the mandible anteriorly beyond its normal point of recovery. Direct violence, unilaterally applied against the angle of the jaw when the mouth is open is also a sufficient cause. A tendency to unilateral dislocation may likewise be due to an imbalanced position of the teeth, causing them to act in the nature of a pry.

Fixation of one articulation, due to pathological influences which are arthritic in character, necessarily requires hypermobility of the opposite articulation, which in turn renders the hypermobile articulation susceptible to subluxation or dislocation. Extension of inflammation to the joint may result from otitis media, pharyngitis, parotitis, etc., with consequent restriction of the joint involved.

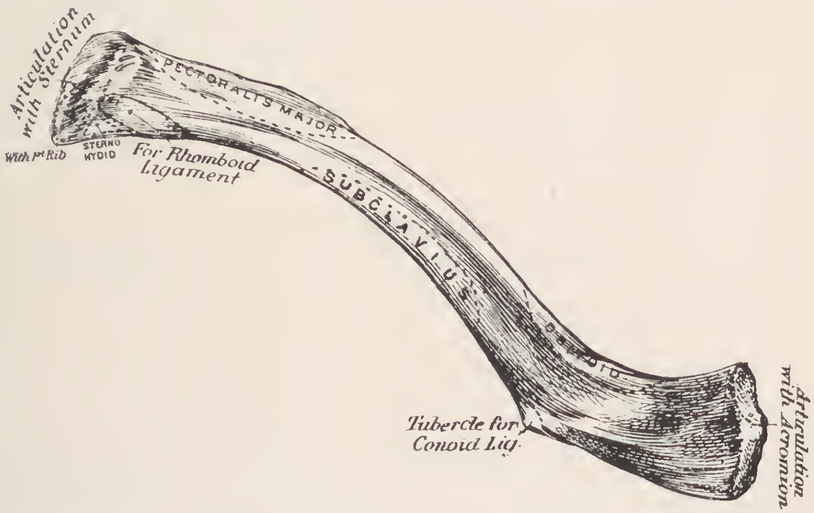
The symptoms are of such a character that the mouth is held open, the lower jaw immobilized and projected somewhat forward. The condyle is in front of its normal position, rendering mastication impossible, articulation and deglutition difficult. Complete dislocation is rare; incomplete, with fixation, common.

Treatment: First, depress the chin and, if possible, open the mouth widely so as to relax the lateral ligaments. After this is accomplished press the condyle backward, maintaining a fulcrum by downward pressure against the junction of rami and the body, closing the mouth under resistance to the point of the chin, as the condyle passes the articular eminence on its way back. The bone thus follows, in returning to its socket, the route by which it escaped from it.

Ashmore gives as the treatment of a hypermobile or relaxed articulation, the forcible replacement of the lesioned condyle and cartilage accompanied by pterygoid and ligamentous stretching on the opposite side, the motion of which is restricted. The bilateral luxation is more common than the unilateral, although the mechanics of the corrective procedure are the same in both.

Luxations of the Sternal End of the Clavicle: The sternal end of the clavicle is much larger than the clavicular notch of the sternum with which it articulates, so that it projects above it, and in front and behind. The joint is a diarthrosis, and its articular surfaces are separated from each other by an inter-articular cartilage, on each side of which is a synovial cavity. The ligaments of the joint are the capsular, posterior and anterior sterno-clavicular, costo-clavicular or rhomboid, and the interclavicular ligament. The inter-clavicular ligament extends across the upper border of the supra-sternal notch, attaching the end of one clavicle to that of the opposite side, also send-

ing fibers into the meniscus or inter-articular fibro-cartilage. The capsular ligament consists of a stratum of fibers which completely surrounds the articulation. These fibers, at the back of the joint, are called the posterior sterno-clavicular ligament, while the fibers in front are known as the anterior sterno-clavicular ligament. The rhomboid or costo-clavicular ligament extends from the sternal end of the first rib upward and outward to the under surface of the clavicle.



The left clavicle, inferior surface.

Movements of the articulation are varied, though limited, owing to the capsular ligament, which is moderately tense in all positions. Motion may be upward, downward, forward, backward, and circumductory. The upward and downward motions occur between the clavicle and the fibro-cartilage. If the arm is elevated, the upper edge of the clavicle and the associated fibro-cartilage are pressed into the sternal socket. If the limb is depressed, the lower edge of the clavicle presses on to the cartilage while the upper edge of the articular surface of the clavicle inclines outward. These movements take place on an antero-posterior axis drawn through the upper compartment of the joint. The forward and backward motions occur between the cartilage and sternum, the clav-

icle with the cartilage moving backward upon the sternum when the shoulder is brought forward, and forward when the shoulder is forced backward. These movements occur on an axis drawn obliquely vertical through the sternal socket. Movement of the shoulder downward and backward is limited by contact of the clavicle with the first rib, and, if continued, this point of contact becomes a center of motion or fulcrum and the sternal end of the clavicle may be forced upward and forward out of its normal position. Dislocations may be complete or incomplete and may be upward, forward, backward; and if incomplete, inward toward the medial line. When displacement is either forward or backward, it is usually downward as well.

Dislocation is most common in males between the ages of 30 and 50. The dislocation forward is usually caused by the shoulder being forced backward, or backward and downward. The anterior sterno-clavicular ligament is severely stretched and may be ruptured, in which case dislocation ensues. This is the most common type of luxation.

Reduction is effected by drawing the shoulder outward and slightly backward, making pressure backward on the dislocated end of the bone, when it is in juxtaposition to the manubrium, after which the shoulder is carried slightly forward, and the bone is directed into its socket. Immobilize the shoulder well forward until repair of the torn ligaments has taken place. For this purpose use a Velpeau bandage, a plaster of Paris dressing or pressure pads. It may be necessary to keep the patient in bed for a time in order to prevent the weight of the shoulder from tending to reproduce the condition.

Dislocation backward is the result of direct force applied to the end of the bone or indirectly by force which presses the shoulder forward and inward. Dislocation may be complete or incomplete. Reduction can be accomplished by drawing the shoulder outward and backward. Recurrence of this dis-

placement should be opposed by dressings that hold the shoulder back and down.

Dislocation upward is the result of sudden trauma, causing a forcible depression of the shoulder at the acromial end of the clavicle; causing, usually, a rupture of the upper portion of the capsular ligament. Reduction is effected by drawing the shoulder outward and making direct pressure downward and outward upon the sternal end of the clavicle. Fixation of the shoulder and the recumbent position should be employed to maintain the reduction.

Luxations of the Acromial end of the Clavicle: The outer portion of the clavicle is attached to the scapula at two points: by its extreme end to the inner margin of the acromion by the acromio-clavicular joint and more medially to the coracoid process by the coraco-clavicular ligament. The acromio-clavicular joint is surrounded by a capsular ligament which usually contains an inter-articular fibro-cartilage. The articular surfaces are flat and oval, their long axes being antero-posterior. The upper edge of the end of the clavicle is at a slightly higher level than the upper surface of the acromion. The coraco-calvicular ligament consists of two parts, the conoid, which is postero-internal; and the trapezoid, which is antero-external.

In movements of the shoulder girdle, the scapula moves beneath the outer end of the clavicle, and the clavicle in turn moves upon the sternum so that the entire scapula describes an arc of a circle the center of which is the sterno-clavicular joint and the radius of which is the clavicle. The acromio-clavicular joint allows the scapula to move upon the thorax, forward and backward, upward and downward, and in a rotary direction upon an axis drawn at right angles to the center of the bone. The glenoid cavity thereby maintains its obliquely forward direction, for by means of its articulation with the clavicle the scapula can be advanced upon the thorax and the glenoid cavity at all times kept facing directly outward. These two bones must move in unison at all times.

Complete dislocation results in rupture of the ligaments of the joint proper. The conoid and trapezoid ligaments may also be involved. Dislocation is usually produced by direct displacement of one bone upon the other. The luxation of the clavicle may be upward, downward, or backward, and are respectively termed supra-acromial, sub-acromial, or sub-coracoid dislocations. The first is the most common. The dislocations may be complete or incomplete.

The supra-acromial dislocation is usually the result of a blow received upon the point of the shoulder which is directed downward and with an inward, forward, or backward inclination. Vigorous contraction of the trapezius prevents the clavicle from accompanying the acromion in its descent, as does also contact with the first rib. Diagnosis is easily accomplished by noting the marked change in the relations to the bones. To reduce, the shoulder should be drawn either directly upward, or with a slight outward or backward inclination; at the same time counter force is directed to the outer end of the clavicle, pressing it directly back to its proper position. Fixation and retention of the reduction are thereafter necessary.

The Sub-acromial dislocations are rare. They may be the result of direct violence against the front of the shoulder. Voluntary movements of the arms are interfered with and sometimes entirely prevented. Persistent numbness and tingling may indicate pressure upon the brachial plexus. Reduction is accomplished by drawing the shoulder outward and backward, maintaining the arm parallel to the trunk and securing counter extension with a bandage passed around the chest. The arms should be immobilized against the torso with the forearm supported by a body-bandage and sling.

Sub-coracoid dislocations are characterized by ecchymosis and pain in the coraco-acromial region, depression over the normal point of the clavicle, with the bone inclined downward and outward and with the acromial end lodged in the

axilla. The whole shoulder is inclined downward and forward. Reduction can be made by disengaging the clavicle from under the coracoid process and at the same time forcing the shoulder backward and outward.

The Depressed Clavicle: This condition is a distinct fixation of the clavicle in which movement of the bone is considerably impaired, limiting to some extent the action of the shoulder-girdle and interfering with both circulatory and lymphatic drainage through the anterior portion of the cervical column. The anterior jugular vein may be particularly affected, in which case the thyroid may be involved through venus retardation. The clavicle is not necessarily luxated, though fixed and bound down by abnormal muscular and ligamentous tension. The object of treatment is to increase the mobility both of the sterno-clavicular and acromio-clavicular articulations.

The method by which this can be accomplished is as follows:

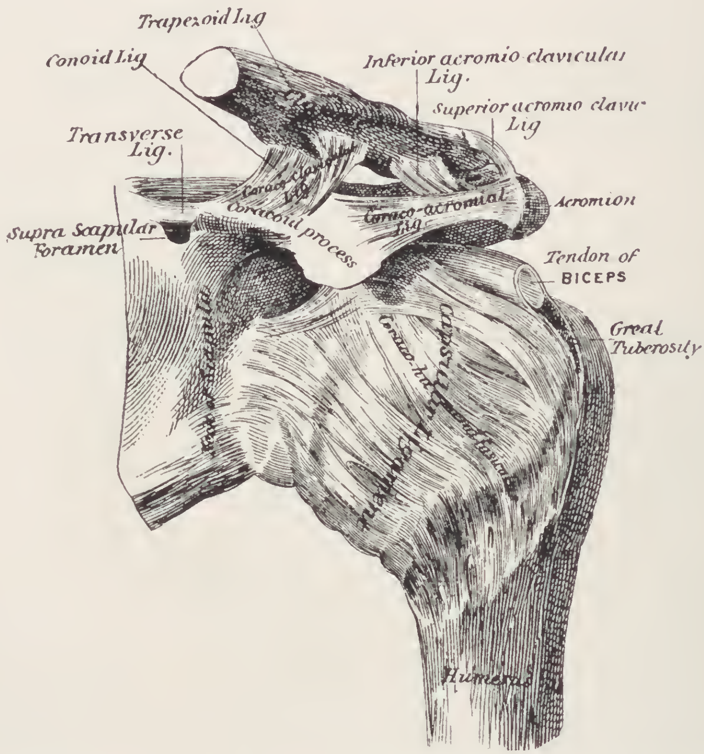
With the patient supine, the operator flexes the forearm at right angles with the upper arm and with the latter close to the body brings pressure against the point of the elbow. This raises the shoulder girdle and affords the operator an opportunity to fix a fulcrum behind the outer portion of the middle third of the collar bone by placing the fingers behind it at this point. The next step in the procedure is to bring the point of the elbow across the chest to the midline, still maintaining the elevation of the shoulder girdle and the fulcrum behind the clavicle. The next step is to elevate the point of the elbow to a level with the top of the shoulder, and at the same time bring a slight lift against the clavicle with the fingers. From this point sweep the point of the elbow directly lateralward so that the upper arm is at right angles to the torso and in a position of abduction. Exaggerate the point of leverage force by bringing added pressure against the fulcrum and, at the same time, allow the forearm of the patient

to rotate so that the fingers point directly downward—thus causing an inward rotation of the humerus on its long axis. The humerus at this time is in such a position that its long axis conforms nearly to the long axis of the clavicle and is therefore a leverage influence to force the clavicle forward and outward. The point of the fulcrum can be shifted slightly, inward or outward, medialward or lateralward, depending upon toward which end of the clavicle the operator wishes to bring the greatest amount of leverage.

Luxations of the Shoulder Joint: The shoulder is a diathrodial ball-and-socket joint and is the most perfect and movable of all the joints. Atmospheric pressure and its muscles have as much to do with retaining it in position as its ligaments. Its construction and position, together with the looseness of its capsule, render it especially liable to displacement. The ligaments of the shoulder joint are the capsular, gleno-humeral, coraco-humeral, and the glenoid. The capsular ligament is a loose sac attaching on one side to the edge of the glenoid cavity, the anatomical neck of the scapula and the rim of the glenoid ligament, and on the other to the anatomical neck of the humerus, above at the edge of the articulating surface, and below some distance from the articulating surface. The capsular ligament is comparatively weak, having two openings, one for the long tendon of the biceps, and the other for communication with its bursa. The capsule is strengthened by a reinforcement above called the gleno-humeral ligament. This is sometimes known as the superior gleno-humeral ligament to distinguish it from some bands on the lower anterior portion of the capsule which are known as the middle and inferior gleno-humeral ligaments. The coraco-humeral ligament is a strong band extending from the root and outer border of the coracoid process over the top of the joint and attaching to the neck of the humerus above the greater tuberosity. The glenoid ligament is a wedge-shaped ring of fibrous

Position of patient and operator for raising the clavicles. B indicates fulcrum and pry action obtained by placing the fingers behind the clavicle. The long axis of the humerus and the clavicle are continuous so that forward rotation of the humerus on its long axis determines forward outward rotation of the clavicle. The forearm is flexed to a right angle with the upper arm and with this lever mechanism carried downward in the direction indicated by arrow A forward rotation of the humerus is assured.

cartilage which deepens the glenoid fossa and receives at its upper end the long tendon of the biceps which divides and blends with it on either side.



The left shoulder joint, scapulo-clavicular articulations and ligaments.

The shoulder has two sets of muscles, one connecting the shoulder-girdle with the trunk, and the other the humerus with the shoulder-girdle. Any joint injury followed by consequent disuse leads to muscular paralysis and the muscles directly concerned with the joint atrophy so that the weight of the arm causes the head of the humerus to sag, giving rise to a marked depression beneath the acromion process.

The muscular bellies of the subscapularis, supraspinatus, infraspinatus, and teres minor muscles constitute a muscular capsule to which the shoulder owes much of its stability. The muscular weakness of the joint is a pronounced factor in recurring dislocations.

The movements of the shoulder joint consist of flexion, extension, adduction, abduction, rotation and circumduction. In flexion and extension the axis of motion is oblique and passes through the head and neck of the humerus and the center of the glenoid fossa. The head of the humerus revolves upon the center of the fossa and allows an antero-posterior swinging of the arm, forward in flexion, and backward in extension. In abduction and adduction the humerus rolls up and down on the glenoid fossa, which is fixed. In circumduction the humerus describes a cone, the apex of which is at the shoulder joint and the base at its distal extremity. Rotation occurs around a vertical axis passed from the center of the head to the inner condyle of the humerus and allowing, in forward rotation, the head of the bone to roll backward in the socket as the great tuberosity and shaft are turned forward, and in backward rotation the head of the bone to slide forward as the tuberosity and shaft are turned backward and outward.

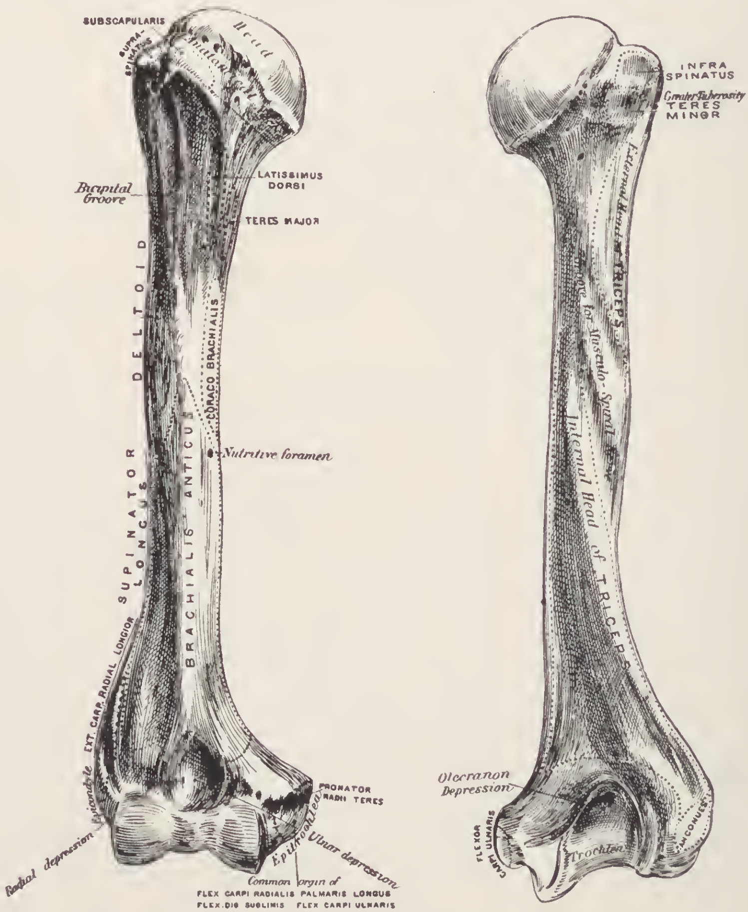
The shoulder joint is controlled largely by the following muscles:

The pectoralis major adducts the bone, drawing it forward, inward and downward; the deltoid muscle abducts it; the latissimus dorsi is an abductor and also produces internal rotation. The supraspinatus is an aid to the deltoid in producing abduction movement. The infraspinatus rotates the head of the humerus outward. The subscapularis rotates it inward. The coracobrachialis draws the bone forward. The pectoralis minor slightly flexes and adducts it. The serratus magnus and trapezius raise the shoulder girdle and the former steadies the scapula in order that the deltoid muscle may raise the humerus. The teres minor aids the infraspinatus which is the chief external rotator of the arm. The teres major assists the latissimus dorsi as an adductor and in some positions acts as an internal rotator of the humerus.

Dislocation of the shoulder-girdle is quite frequent due to its exposed situation, free mobility and anatomical con-

struction. It is encountered in the muscular adult, usually between the ages of 20 and 40. It is rarely found in the very old or very young.

For general purposes of convenience, luxations of the articulation are divided into two gross types. The first type is the anterior dislocation in which the head of the humerus is either on or anterior to the long head of the triceps muscle at the lower edge of the glenoid fossa. This type of luxation is the most common. The second type is the posterior dislocation in which the head is posteriorly displaced.



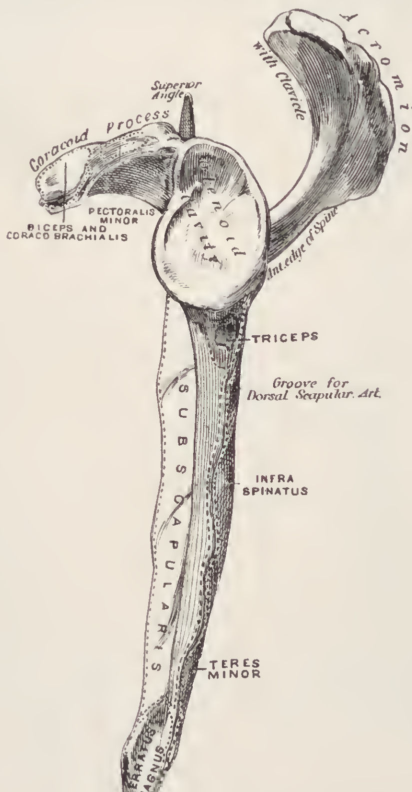
Right humerus, anterior and posterior surface.

Four chief varieties of shoulder-joint dislocation exist, two of which are forward and two backward. There are also two rarer luxations which are respectively known as the supra-coracoid and the luxatio erecta.

As the head of the bone passes through the anterior portion of the capsule it slips beneath the coracoid process. If it moves inward from this point it is called subclavicular, and if downward and outward, subglenoid. Anterior subluxations are produced in hyper-abduction and external rotation with the acromion process acting as a fulcrum to lift the head of the bone from its socket. The lower and anterior portion of the capsule is torn from the rim of the glenoid cavity. The subcoracoid dislocation is characterized by very slight lengthening of the limb with the elbow carried backward and slightly away from the side so that the head of the bone is not readily palpable in the upper and inner part of the axilla, which differs from the subglenoid type in which variety there is considerable lengthening with the elbow carried away from the trunk and slightly backward so that the head of the bone is easily palpable in the axilla.

Probable dislocation is indicated by pain of a sickening character with marked rigidity for some particular combination of movements and great pain on attempted motion. The shoulder is abnormally flattened and the head of the bone no longer bulges out the deltoid muscle. In fact, there is apparent projection of the acromion and a sinking in of the deltoid because of the empty socket. Anterior dislocations can be best reduced by Kocher's method. This is a leverage method and consists of three steps: 1. The abducted elbow is slowly adducted against the side of the torso, with the forearm kept flexed at a right angle to the arm; (2) With the elbow touching the side of the body, and drawn slightly backward, the humerus is externally rotated through an arc of 90 degrees until the forearm points outward from the body, by which maneuver the head of the bone is carried close to the

margin of the glenoid cavity. Gentle and gradual external rotation should be persisted in until all muscular resistance is overcome. The next step is to lift the elbow anteriorly as far forward as it will go so as to form a right angle with the long axis of the body. This brings the head of the humerus up from its low position to the level of the glenoid margin, just opposite the capsular tear, and at the same time relaxes the coracobrachialis muscle, thereby releasing the lesser tuberosity. (3) The third step to complete the reduction is to gradually sweep the forearm inward toward the opposite side of the chest with internal rotation, at the summit of which the hand is placed on the opposite shoulder and the arm brought down to the chest. This throws the bone into place. This method will fail if the posterior portion of the capsule



Lateral aspect of the scapula viewed from the side.

is ruptured, for lack of a fulcrum. In the latter case reduction can be effected only by direct measures utilizing traction with the arm abducted and rotated and then pulling or pushing the bone into the socket.

Posterior dislocations carry the head of the humerus beneath some portion of the spine of the scapula and they are therefore called sub-spinous. If it lies under the posterior portion of the acromion process it is called sub-acromial. These dislocations are rare, and usually occur when the arm is abducted with strong internal rotation. They may result from direct violence against the anterior portion of the shoulder. The posterior part of the capsule is torn and the arm is inverted so that rotation and abduction are impaired. Lengthening is intermediate, the elbow is raised from the side and carried forward, and the head of the bone is palpable beneath the spine of the scapula. The infraspinatus, teres minor and the subscapularis muscles may be ruptured. Reduction is best effected by direct measures, particularly using direct pressure from behind, forward upon the head of the humerus, with counter pressure upon the front of the acromion and an associated traction of the arm.

A rare form of dislocation is the **subclavicular** in which the head of the humerus passes anteriorly and inward to rest between the coracoid process and the clavicle. In this particular case the elbow is carried outward and backward, the arm is shortened and the head of the bone can readily be palpated beneath the clavicle.

The **supra-coracoid luxation** is infrequently found and is associated with fracture of the acromion or coracoid process.

Luxatio erecta is characterized by marked abduction, with the forearm usually at rest behind the occiput or upon the head to avoid pain. It is an exaggerated form of sub-

glenoid luxation in which the head of the humerus has passed under the subscapularis muscle.

Bursitis: The shoulder joint, like other joints, is subject to inflammation as the result of strains, trauma, rheumatic or infectious processes, and occasionally tuberculosis. The deltoid and subacromial bursae are intimately associated and adjoin each other so that when the arm is abducted the entire bursa is subacromial and when adducted is largely subdeltoid. Inflammatory effusion distends the capsule and finally tends to escape at the weakest point. Codman describes three types of bursitis. The first is an acute or spasmodic type with local tenderness on the point of the shoulder, immediately below the acromion process and outside the bicipital groove. This authority further states that about ten degrees of abduction is possible without moving the scapula, after which the scapula is spasmodically locked and moves with the humerus. Pain is referred along the outer side of the arm and around the insertion of the deltoid. The patient may be unable to abduct the arm voluntarily because of the severe pain.

The second type is a subacute or adherent variety in which there are adhesions which cause a definite mechanical block to abduction and external rotation. Abduction is markedly limited and movement beyond ten degrees causes the scapula to move. The pain is localized at about the same points as in the former type with the exception that the tender spot at the base of the bursa does not disappear under the acromion when the arm is abducted as it does in type 1. This is Dawbarn's sign.

The third type is chronic and non-adherent, with thickening and roughening of the bursae. If local tenderness is present Dawbarn's sign can be elicited. There is slight limitation to abduction and external rotation, although there is usually a point at which this produces severe tenderness with some persistence of the pain after motion. The sub-

scapular and infraspinatus bursae usually communicate with the joint cavity and may be involved in joint inflammation.

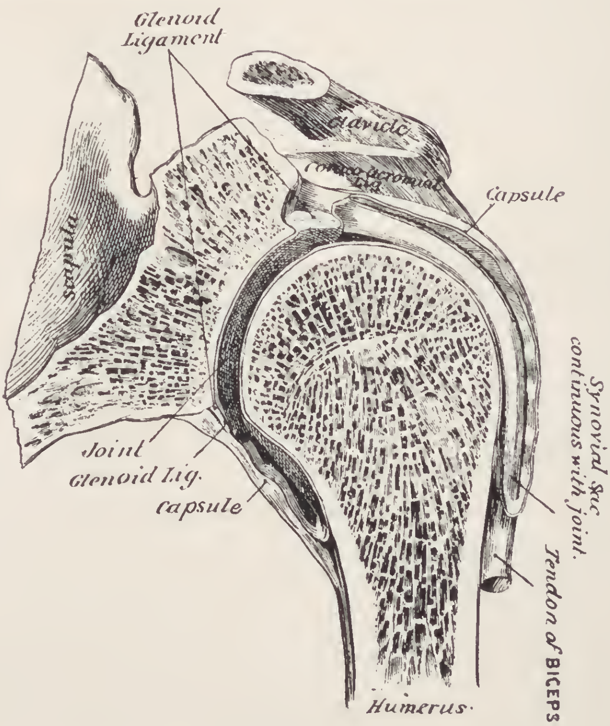
Acute cases of subacromial bursitis can best be treated by keeping the arm abducted in a splint, thus allowing for relaxation of the deltoid and the rotators, and keeping the base of the bursae from coming in contact with the acromion.

In the chronic type adhesions, if present, should be broken up, passive and active movements employed with baking and other adjunctive measures.

A very good way to break up the adhesions of a subacromial bursitis or of the shoulder joint in general is as follows:

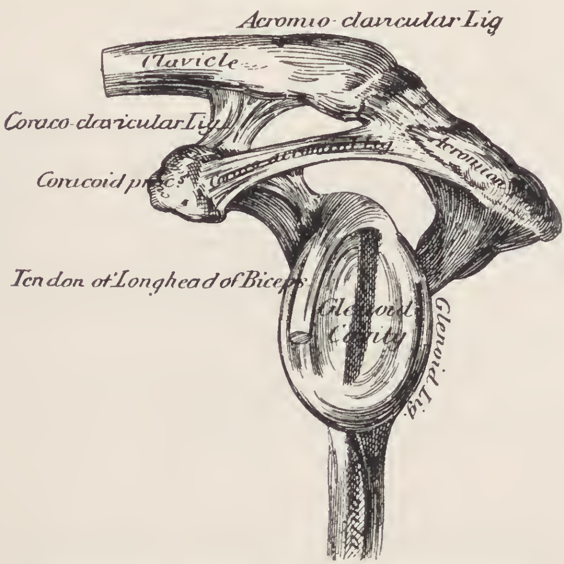
Flex the forearm to a right angle with the upper arm, grasp the wrist of the patient firmly with one hand and cup the point of the patient's elbow in the palm of the other hand. Elevate the shoulder-girdle by bringing upward pressure against the point of the elbow. Bring the point of the elbow to the midline and forcibly supinate the forearm. Follow this with forcible pronation. Then abduct the upper arm, maintaining the shoulder elevation and the position of the hands. Forcibly pronate and supinate at this point, gradually forcing the abduction toward a right angle with the torso. The long axis of the humerus should be shifted to different points in relation to the glenoid cavity, following which the acts of supination and pronation of the forearm with the elbow fixed serve as leverage forces to cause the humerus to rotate on its long axis in both directions, the twisting or torsion effect of which is sufficient to break up any adhesions present. The object in view should be gradually to approach a degree of abduction in which the upper arm is parallel to and on a level with the shoulder and at this point to break up completely such adhesions as are present by forcible supination and pronation of the forearm.

Derangement of the Biceps Tendon: The long tendon of the biceps muscle is lodged in the bicipital groove between the two tuberosities of the humerus. With the arm hanging by the side, it passes directly forward. It runs over the head of the humerus and under the coraco-acromial ligament and at the upper part of the glenoid fossa is prolonged into the glenoid ligament which bifurcates and sends fibers right and left into the glenoid labrum. It is covered by a synovial sheath which passes with it through the opening in the capsule and a short distance along the bicipital groove. It is held in the groove by the transverse humeral ligament which is a fibrous expansion from the pectoralis major tendon. The tendon of the long head of the biceps habitually escapes rupture but when this occurs it retracts and becomes united with the bone.



Left shoulder joint, frontal section, from in front.

It is frequently subject to minor derangement, the exact characteristics of which are obscure. This is probably in the nature of a slight catch of the tendon due to a minor slip sideways from the center of the groove due to violent muscular action. Such combinations of movements as those associated with throwing a baseball, or playing tennis, in which there is inward rotation of the humerus on its long axis, circumduction of the upper arm will allow sufficient play to permit a lateral deflection of the ligament. Forcible external rotation, with the upper arm elevated and drawn back, will produce lateral strain in the opposite direction. Any overhanded swing in which the upper arm is in an elevated position and the circumduction and rotation on its long axis violent, may under certain conditions produce this minor lesion; for although there is relaxation of the ligament because of the elevated position of the upper arm there is also a lateral strain which the relaxed ligament cannot resist. The traumatic influence of this condition may result in an associated synovitis. Joint inflammations of a rheumatic type may, through extension, involve the sheath and synovial membrane covering the tendon.



Left clavicle and scapula, seen from without.

Localized pain and tenderness over the tendon at the point where it passes under the transverse humeral ligament are characteristic. Pronation and supination aggravate this pain, particularly if a certain amount of circumduction of the shoulder is combined with these moves. Limitation of motion, because of the pain induced, is present, although the arm can be passively moved to almost any point. The tendon is apparently fixed so that there is palpably decreased freedom and play of motion in the groove.

Reduction is easy. With the patient supine, place the knee under the humerus close to the shoulder joint to act as a fulcrum. Fix the tendon between the finger and thumb. Abduct the upper arm to a right angle with the torso and the forearm to a right angle with the upper arm. Interlock the fingers with those of the patient and with this guiding influence strongly supinate the forearm. This will cause the humerus to rotate so that the groove will move forward, inward and slightly down. At the same time gradually extend the forearm. Before the completion of the extension, completely and strongly reverse the arc of motion by bringing the forearm quickly into strong pronation. This causes the groove to move backward, outward and slightly upward. During the entire procedure the operator should hold the tendon so as forcibly to maintain it in as stationary a position as possible. The catch is thereby dislodged and the tendon forced deeply into the groove.

Luxations of the Elbow Joint: The elbow joint is a diathrodial joint of the ginglymus type and depends upon the structural conformation of its bones rather than upon its ligaments for security and strength. The bones comprising it are the lower end of the humerus above and the upper ends of the radius and ulna below. The articular surface of the humerus is received partly by the great sigmoid cavity of the ulna and partly upon the cup-shaped superior surface of the head of the radius.

Position for reduction of fixation of the tendon of the long head of the biceps. A indicates position of forearm. B indicates direction in which forearm is carried forward into position to obtain forward rotation of the humerus on its long axis. From C forearm is carried to D into supination and full extension. This latter move causes rotation of the humerus backward on its long axis. During the entire procedure the tendon is held firmly between the thumb and forefinger.

The articulating portions of the humerus are known respectively as the trochlea and the capitellum. On each side of the lower end of the humerus is a prominence known as an epicondyle. The inner one is called the epitrochlea and is more prominent than the outer. Above the level of the epitrochlea on the posterior aspect of the humerus is a deep depression, the olecranon fossa, into which the tip of the olecranon process of the ulna is received when the joint is extended. Above it anteriorly is a small depression for reception of the coranoid process of the ulna when the joint is flexed. The concave cylindrical head of the radius not only articulates with

Anterior view of the right elbow joint showing anterior and internal ligaments.

the capitellum but also articulates with the sigmoid cavity on the outer side of the ulna. The outer border of the head of the radius can be palpated about three-quarters of an inch below the upper condyle and can be felt to move when the forearm is gently rotated.

The ligaments form a large capsule which blends with the orbicular ligament and embraces the elbow and superior radio-ulna joint. The orbicular or annular ligament is placed like a loop about the head and neck of the radius, binding it to the lesser sigmoid cavity of the ulna. The ligaments are known as the anterior, posterior, internal and external. Additional fibers arising from the external condyle of the humerus strengthen the joint laterally.

The movements of the elbow are those of a true hinge joint and consist of flexion and extension. These movements take place on an oblique axis. In flexion the forearm inclines inward and in extension outward. The radius rotates upon the humerus when following the ulna in all its movements. In extension and supination the head of the radius rotates backward markedly and is only partially in articular contact with the capitellum. In the position of midflexion the radius is sufficiently stabilized by the humerus to permit pronation and supination to take place without difficulty and at their maximum mechanical advantage.

Dislocation of the elbow joint is fairly common, particularly in children. One or both bones may be dislocated and the dislocation may be complete or incomplete. The displacement is more commonly backward. The causes of backward dislocation are falls on the outstretched hand or an inward twist of the ulna. The forearm is flexed, supinated and shortened with marked projection of the olecranon and head of the radius. The changed relations of the olecranon, the head of the radius and the two condyles are diagnostic.

To reduce the dislocation relax the triceps by extending the forearm, press upon the radius and ulna to direct their

return, apply counter pressure in front of the elbow joint and complete the adjustment with extension of the forearm and counter extension of the arm. The muscle leverage produced by extension of the forearm superimposed to the other mechanical forces pulls the bones into place.

In dislocation of both bones forward, the cause is usually a blow on the olecranon when the arm is flexed. The forearm is flexed and lengthened with the olecranon on a level with the condyles. Reduction consists of forced flexion, extension, and direct pressure.

Inward dislocation of the elbow is ordinarily incomplete, the head of the radius usually leaving the capitellum but the olecranon sliding only to the inner margin of the trochlea. Reduction consists of extension, counter extension with the arm slightly flexed, and at the same time of applying direct pressure on the humerus inward and counter pressure on the ulna outward.

In **outward dislocation** the forearm is flexed, fixed and pronated; and the head of the radius projects externally, and the inner condyle internally.

In inward dislocations the forearm is flexed, pronated and fixed and the ulna projects internally.

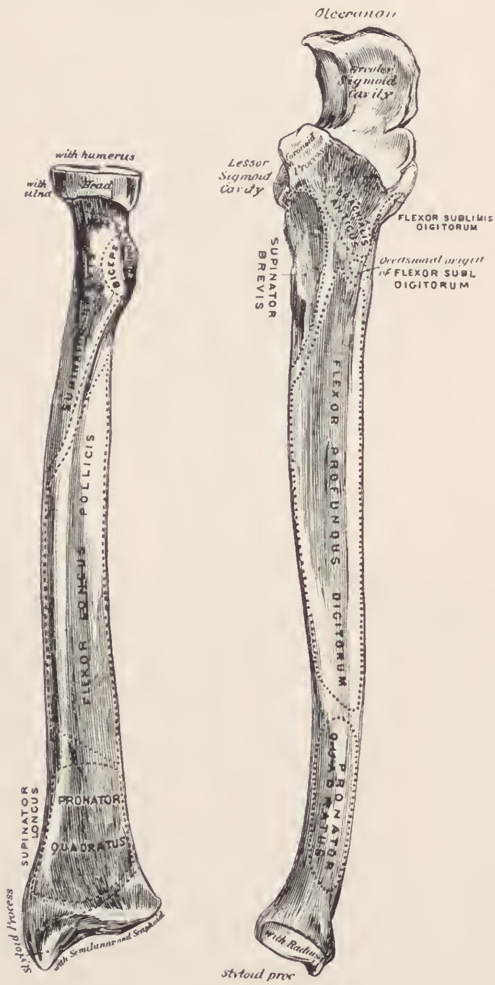
After-support should consist of placing the arm in the Jones position with immobilization for at least two weeks, using passive movement to prevent permanent fixation.

Dislocation of the ulna singly occurs infrequently and in a backward direction. The forearm is fixed in flexion and pronation with the head of the radius in its normal position and the olecranon projecting backward.

Dislocation of the radius forward is the most frequent form of dislocation at the elbow. The forearm is fixed in semi-flexion and in very slight pronation. The head of the radius is palpable in front of the outer condyle. If the orbicular ligament is ruptured the condition is apt to recur. This

type of luxation is the result of direct trauma or falls upon the hand with the forearm in pronation. Reduction consists of flexion, counter extension and direct manipulation. The after treatment should consist of the Jones position and passive movement.

Backward dislocation of the radius is less common and is characterized by slight flexion of the forearm, fixation and pronation. The head of the radius is palpable behind the outer condyle. Reduction is effected by flexion, extension, counter extension and manipulation.



Bones of the right forearm, anterior view.

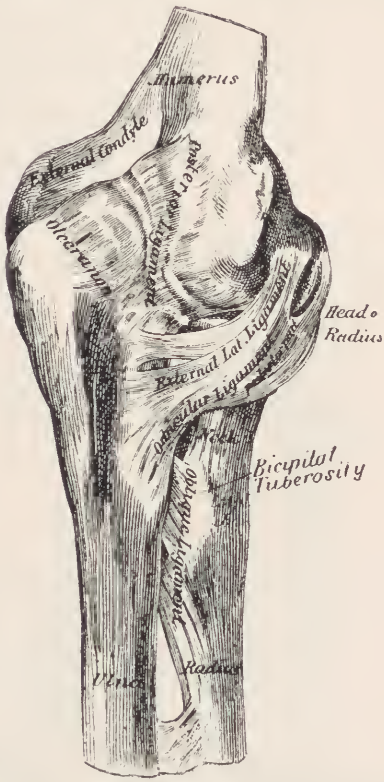
Dislocation of the radius outward is very rare. Reduction is effected by extension, counter extension, pressure and manipulation with after treatment, immobilization in the Jones position and passive movement.

Subluxation of the Head of the Radius: This injury occurs frequently in children between two and four years of age. It is the result of traction of the hand or forearm with an incidental twist of the elbow in the direction of supination or pronation. Falls may produce it. In the adult a slight forward subluxation of the radial head may occur as the result of an act of violent supination. When found in the adult the radial head is immobilized in forward rotation. This may be encountered in tennis-players, golfers, and baseball players. In children the condition is more severe. Complete flexion and extension are very painful, although easy movement is free from pain. Pain is localized around the elbow joint and pressure over the head of the radius aggravates it. Any considerable degree of pronation or supination is painful. An audible click may be sensed above the elbow or at the wrist in the child. In the adult there is apparent fixation of the head of the radius which fails to rotate under the orbicular ligament. The tuberosity of the radius may be slightly locked behind the inner edge of the ulna and there may also be a complicating subluxation of the triangular cartilage of the wrist. Reduction in the child is best accomplished by flexing the forearm to a right angle with the arm, and forcibly supinating it. An anterior angular splint should be worn for four or five days.

The reduction of the subluxation in the adult is in the following manner:

First obtain a fulcrum or fixed point behind the head of the radius so that this point of contact can act both as a fulcrum and a pry to force the ulna and radius apart and break fixation. Superimposed to this the leverage force of

the forearm is employed by using it either as a direct lever handle or with forcible pronation as a means of obtaining indirect muscular leverage. In either case the fulcrum should be at the same point and the operator's fingers should be placed below the head of the radius on its inner border to



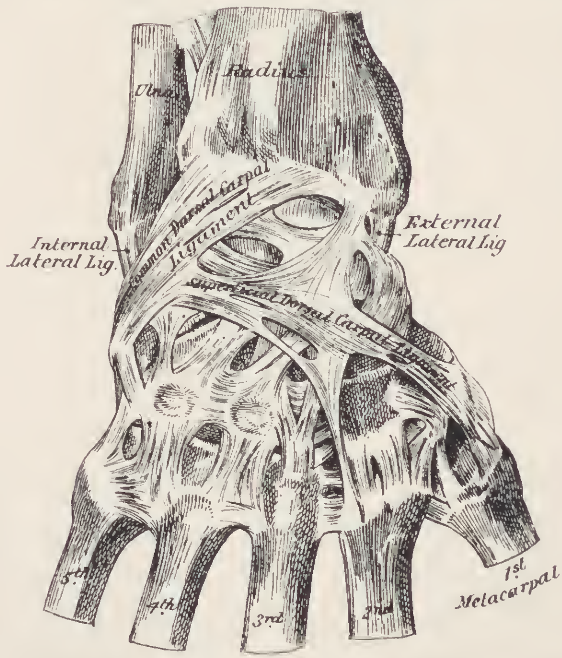
Right elbow joint, posterior view, showing posterior and external ligaments.

effect a pry action on the articulation. If muscular leverage is to be utilized the operator should interlock his fingers with those of the patient and forcibly pronate, at the same time bringing the forearm into extension and adding a little traction in the long axis of the bones. If the lower arm is to be used as a direct lever, lock the wrist slightly above the articulations with the hand between the torso and the upper arm or between the two knees. Bring the forearm into extension and superimpose traction in the long axis of the bones,

at the summit of which bring corrective force against the radius with the fingers, and superimpose leverage force with the lever handle.

Dislocation of the Inferior Radio-Ulnar Articulation: The ulna may be dislocated backward by forcible pronation. The wrist is fixed in pronation, supination is impossible and the hand powerless. The head of the bone projects posteriorly on the radius. Reduce with forcible supination of the hand and pressure against the ulna.

Dislocation forward is caused by forcible supination. The ulna projects anteriorly and pronation is impossible. Reduce by extension, forcible pronation and direct pressure.

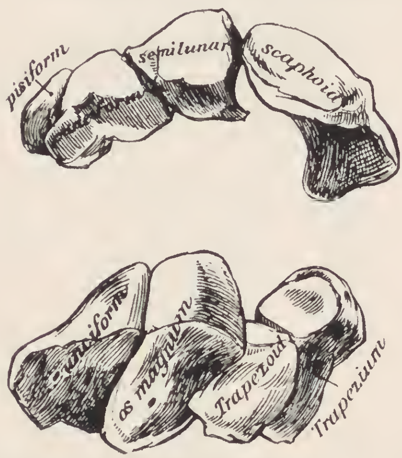


Ligaments of the wrist and hand, posterior view.

Dislocation of the Wrist: Dislocation of the wrist is infrequent, and is caused usually by a fall upon the hand. If the dislocation is backward, it resembles Colles' fracture. The carpus projects on the dorsal sur-

face of the forearm, fingers are flexed and the wrist bent backward. The relation of the styloid process of the radius to the styloid process of the ulna is unchanged, if the condition is a dislocation and not a fracture.

If the dislocation is forward the carpus projects anteriorly. Reduce by extension, counter extension and direct manipulation. Splint for two weeks, and employ meanwhile passive motion. Dislocation of the inferior radio-ulnar articulation is very unusual and is practically always accompanied by fracture. The forearm is usually pronated; if forward, dislocation and supinated; if backward, dislocation. In both cases, the space between the stvloid processes is decreased.

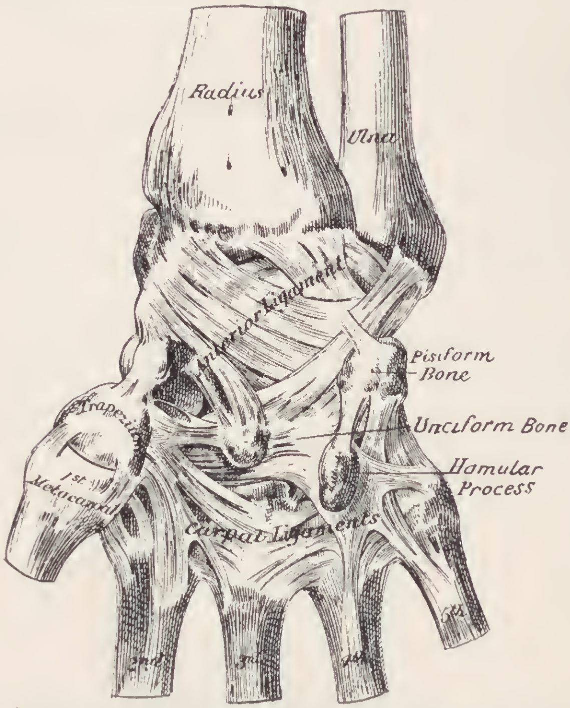


Carpal bones of the left hand, palmar surface.

Dislocation of the Carpal Bones: Dislocation of the individual bones of the carpus is not frequent. The most common type is the semilunar, and the scaphoid, pisiform, trapezoid, trapezium, and unciform follow in the order named. The os magnum may be dislocated backward; the semilunar may be dislocated forward. Reduction can be effected by hyperextension, hyperflexion, over a fulcrum maintained with the thumbs against the bone in lesion.

Dislocation of the metacarpal bones is usually confined to a backward dislocation of the first metacarpal.

Dislocation of a metacarpo-phalangeal articulation is uncommon and is usually backward.



Ligaments of the right wrist and hand, anterior view.

Dislocation of a phalanx, complete or incomplete, is more common and is usually between the first and second phalanges. Reduction of these conditions is best effected by extension, counter extension and immobilization in a splint for a period of seven days.

Luxations of the Hip: The hip joint is composed of the globular head of the femur and the cotyloid cavity or acetabulum of the os innominatum. It is a diarthrodial joint of the ball and socket order. Both articular surfaces are covered with cartilage, the depression for the ligamentum teres being the only exception. The depth of the cavity is considerably increased by its fibro-cartilaginous rim. The ligaments of the joint are the capsular, transverse, ligamentum teres, and the cotyloid cartilage.

The **capsular ligament** is extremely strong, large, and somewhat loose. Accessory to the capsule are three auxiliary bands, the **ilio-femoral ligament,** attaching from below and behind the anterior superior spine to the anterior edge of the greater trochanter; the **ischio-femoral ligament,** attaching from a groove on the ischium to the outer posterior portion of the capsule; and the **pectineo-femoral** band which attaches to the pectineal eminence and pubic end of the cotyloid notch

Left femur, anterior surface.

and to the neck of the femur via the ilio-femoral ligament with which it blends.

Other strengthening bands are the ilio-trochanteric and tendino-trochanteric.

The **ligamentum teres** is a short interarticular band attaching from the acetabular notch to the head of the femur. The **transverse ligament** passes across the cotyloid notch, thereby completing the rim of the acetabulum and supporting the cotyloid fibro-cartilage. The **cotyloid fibro-cartilage** deepens the acetabulum and is thickest at the iliac and ischial margins.

Movements of the hip joint are flexion, extension, abduction, adduction, circumduction and rotation. Flexion is limited by the hamstrings; extension by the ilio-femoral ligament; abduction by the pectineo-femoral ligament; external rotation by the ilio-femoral ligament and ligamentum teres; adduction by contact with the opposite limb, ischio-capsular and capsular ligaments; and inward rotation by the ilio-femoral, ischio-femoral ligaments and ligamentum teres.

Dislocations of the hip are either anterior or posterior in their relation to Nelaton's line, which is a line drawn from the anterior superior spine to the most prominent part of the tuberosity of the ischium. In the normal limb the top of the great trochanter touches this line. Bryant uses the following method in deciding the position of the great trochanter.

The patient being flat on his back, a line is dropped vertically from the anterior superior spine. From the top of the great trochanter a straight line is drawn in the long axis of the thigh to meet the first. To complete the triangle a line is drawn from the anterior superior spine to the top of the trochanter. The second line is subject to the greater variations. This line practically coincides with Nelaton's.

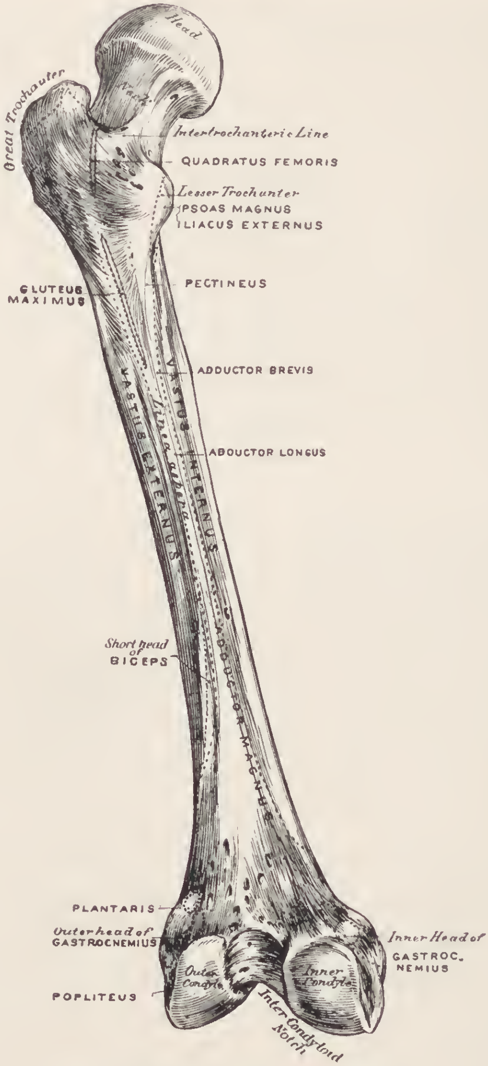
When the head of the femur leaves its socket it passes

down anteriorly or posteriorly to Nelaton's line and is therefore an anterior or posterior luxation. Posterior and anterior luxations may be either high or low.

A primary anterior luxation is low thyroid if the femoral head lies beneath the level of the fossa of the acetabulum. External rotation at this time allows it to rotate upward and forward and it thus becomes high anterior or pubic.

A primary posterior luxation allows the head of the femur to rest on or near the spine of the ischium or in the sciatic notch and is a low reversed thyroid. If followed by internal rotation it becomes a posterior high luxation with the head of the femur resting on the dorsal aspect of the ilium.

Congenital luxations are usually posterior and one-half of all dislocations are high posterior. Because of the position of the neck of the femur, at an approximate angle of 128 degrees with the shaft of the bone, inward rotation of the shaft causes the head to rotate backward and outward, and outward rotation of the shaft causes the head to rotate forward and inward. Abduction produces a thyroid or obturator luxation as the head is raised out of its socket by the long lever action of the shaft of the femur and the fulcrum effect of the neck in contact with the upper rim of the acetabulum and thereby allows the short arm of the lever with the head at its distal extremity to be leveraged out of the socket and down. If, from the position of hyper-abduction, outward rotation of the shaft follows, the head passes forward into a pubic position; while if, from this position, slight flexion and inward rotation follows, the head rotates into a posterior position. If the luxation occurs in adduction and flexion of the thigh with subsequent strong inward rotation, the ilio-femoral ligament locks around the neck of the bone and acts as a fulcrum so that as the shaft revolves on its long axis inward, the head rotates outward and downward and a dorsal luxation follows.



Left femur, posterior surface.

The rent in the capsule is only sufficiently large to allow the head to escape and return. When the luxation is posterior there is inversion of the foot, adduction of the thigh, together with slight flexion and shortening. When luxated anteriorly there is eversion of the foot, marked, if pubic, and only slight if low thyroid or obturator, in contra-distinction to abduction of the thigh, which is marked in the thyroid and less in

the pubic. There is no shortening and there may be a very slight lengthening. The thigh is flexed in the thyroid luxation but not in the pubic.

Reduction can be effected directly or indirectly by leverage or by the utilization of both types. The ilio-femoral ligament is a powerful fulcrum for indirect methods.

A direct method for posterior luxations is to place the patient on his back on a low hard surface. Flex the knee on the thigh and the thigh on the abdomen, in both cases to a right angle. Adduct the thigh slightly to relax the ilio-femoral ligament. With the ankle held, lift upward and inward in the apex of the flexed knee to raise the head to the level of the acetabulum. Rotate the thigh gently inward.

An indirect method is to place the patient on his back, flex the leg on the thigh and the thigh on the abdomen, adduct across the midline and from this point exaggerate the flexion of the leg on the thigh. Gradually bring the flexed knee across the midline to a position of abduction. Return to a point wherein the flexion of the knee is at right angles with the thigh, and the thigh at right angles with the abdomen, maintaining, meanwhile, the abduction. At this point perform external circumduction, lift under the head of the bone directly or establish a fulcrum against the greater trochanter to carry it to the level of the socket; and with completion of the external circumduction and rotation bring the femur into extension.

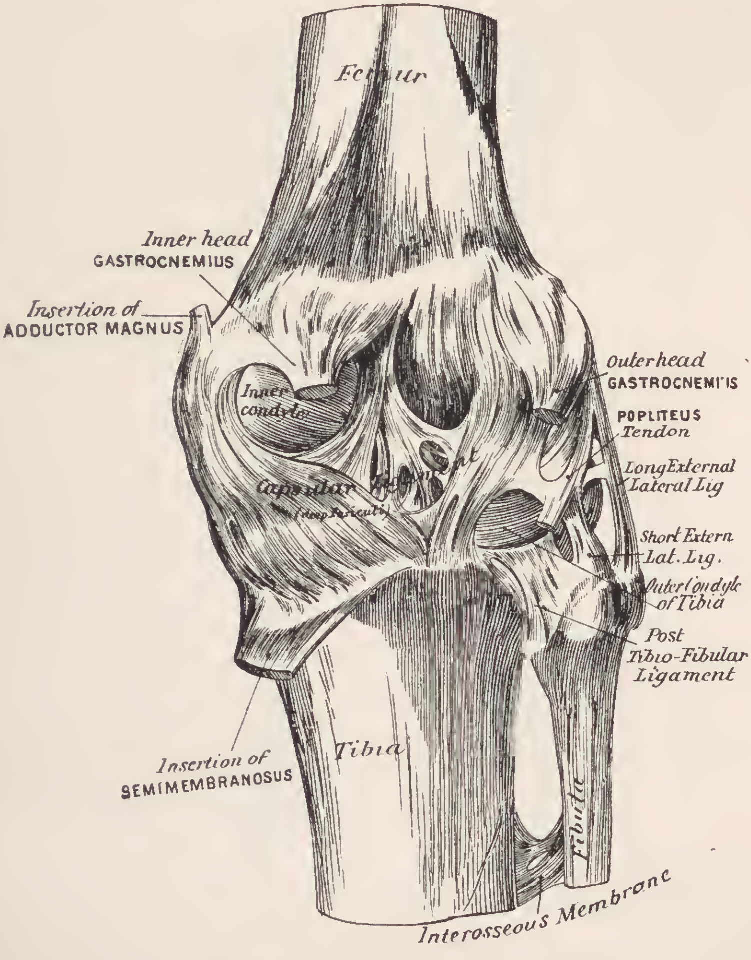
In anterior luxations, first slightly abduct the thigh and rotate the femur on its long axis inward. From this point flex the knee and thigh a bit beyond the right angle with the leg and thigh respectively. Lift up and out under the apex of the flexed knee, keeping the foot slightly inverted so that the shaft is in a slight degree of internal rotation. From this point make slight external circumduction of the knee using external rotation. The pelvis must be fixed in this procedure. At the completion of external circumduction bring the limb into extension straight down and in the long axis of the body.

Allis advises against too great a circular sweep of the knee because of the danger of catching up the sciatic nerve. If such occurs he advises redislocation of the femur and disengaging of the nerve by extension of the thigh, flexion of the leg on the thigh, and internal rotation of the femur by turning the ankle out. Shaking or jarring the nerve may remove entanglement. Abduction or adduction, or rotation of the femur in the socket without flexing the leg may free the nerve. If the above methods fail he advises operation to release the catch.

Luxation of the Knee: The knee joint is grossly composed of two joints: that formed by the patella and femur, and that by the femur and tibia. The latter is subdivided into two articulating portions, each formed by one of the condyles of the femur and the opposing portion of the upper surface of the tibia.

The ligaments which hold the femur to the tibia and fibula are the external and internal lateral, the posterior and the crucial. The internal lateral ligament attaches from the internal tuberosity of the femur to the inner side of the shaft of the tibia. The external lateral attaches from the external tuberosity of the femur to the head of the fibula. The short external lateral ligament extends from the side of the condyle to the styloid process of fibula. The posterior ligament extends from the upper part of the intercondylar fossa of the femur to the posterior margin of the head of the tibia. The crucial ligaments attach from either side of the intercondylar notch, which is the line of separation of the condyles of the femur, to the depression in front of and behind the spine of the tibia which interrupts the depression between the condylar surfaces of the tibia at their center.

The **semilunar fibro-cartilages** are intra-articular and attached to the head of the tibia at their outer margins and ends. They have free, smooth surfaces above and below. They are triangular in shape, their peripheral borders being



The right knee joint, posterior view.

thick and their central portions thin. They are hemispherical rings which leave the corresponding condylar surfaces of the tibia uncovered at the center. The internal one is semicircular, the external one is more nearly a complete circle. The external cartilage is slightly movable, this allowing greater outward rotation of the leg at the end of extension. The internal cartilage is fixed, serving to maintain a deeper depression for reception of the internal condyle.

The **synovial membrane** frequently communicates with

Anterior surface of right tibia and fibula.

the bursa under the triceps tendon and is reflected to invest the crucial ligaments. It rests upon a mass of fat between the tibia and patella, forms two lateral folds, the alar ligaments, and reflects backward from its middle another fold which attaches to the front of the intercondylar notch, dividing the joint into three freely communicating chambers.

The femoro-tibial joint, by a combination of arthrodial and rotary movements, is functionally a ginglymo-arthrodial joint. The patella rests upon the upper part of the trochlear surface of the femur in extension, and moves downward and

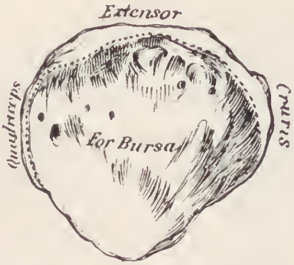
slightly outward in flexion, so that it rests by its upper, outer facet on the front of the external condyle, and by its inner facet against the outer margin of the internal condyle. In extension the tibia undergoes slight outward rotation and flexion is accompanied by slight inward rotation of the tibia.

Luxation of the knee or the femoro-tibial joint is rare. It may be complete or incomplete, simple or compound.

Luxations may be divided into those types the classifications of which are dependent upon the direction in which the tibia is displaced. It may be displaced forward, backward, outward, inward, in outward rotation, and in inward rotation. Reduction is usually easy when attempted under traction with coaptative pressure upon the adjoining ends of the femur and tibia. If the dislocation is forward, use a very slight degree of extension—not forced extension because of the possibility of injury to the popliteal vessels. If the dislocation is backward, adjust with slight flexion of the knee and hip; if the dislocation is lateral use a certain amount of lateral flexion. If the lesion is an outward rotation, reduce with internal rotation; if the lesion is an inward rotation, reduce with outward rotation.

The limb should be immobilized for a period of six or eight weeks, at the least, in order that the torn ligaments may have a chance to reunite. A firm dressing should be maintained for at least six weeks. Massage and passive movement should be employed during this time to avoid the loss of normal mobility. Supportive measures must be utilized for at least a period of three months.

Luxations of the Patella: Luxations of the patella are rare. It may be displaced to different points on the outer or inner side when the knee is in extension or partially flexed. This displacement may be accompanied with varying degrees of rotation through the longitudinal axis of the bone.



Right patella, anterior surface.

Left patella, posterior surface.

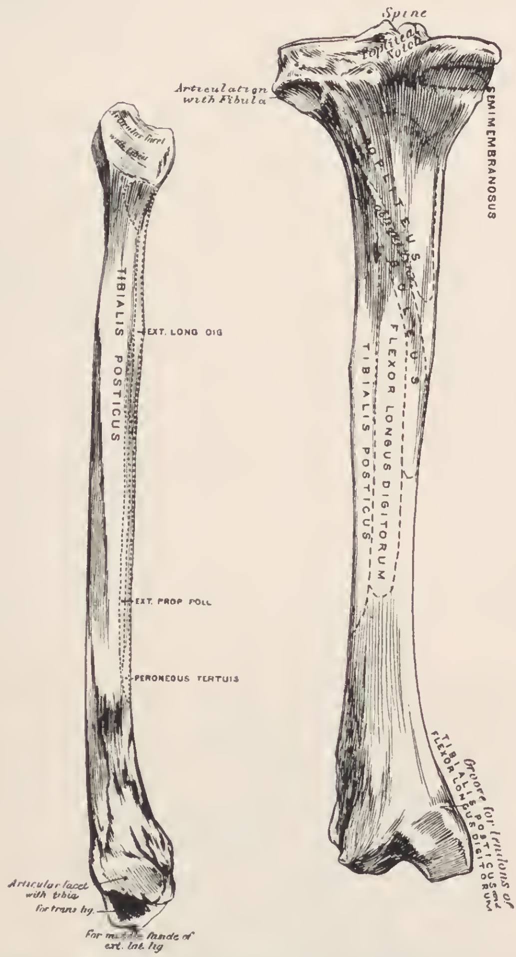
Methods of adjustment which are productive of the best results are first to relax the quadriceps by flexion of the hip and full extension of the knee. Direct pressure can then be applied with the hands upon the patella.

Luxation of the Fibula: The fibula may be dislocated at either end as a result of external violence, muscular action, pathological influence or because of unequal growth or shape of the bones. Luxation of the upper end forward and outward, with rotation through the long axis of the bone is the most frequent. It occurs in children more frequently than in adults. It is usually caused by a fall with the leg bent under the body and the foot strongly inverted, and depressed. When purely muscular it is usually through forcible depression and inversion of the forefoot.

Diagnosis of this condition is comparatively easy, as there is a depression where the head of the bone is normally situated, and palpation will reveal a freely movable upper extremity, ending in a projection, the head of the bone, which is anterior and forward to its normal location. The tendon of the biceps show plainly and its contour is abnormal. Walking is usually impossible because of the pain, although the patient can move the knee quite freely.

Reduction is best effected by direct manipulation with knee partially flexed so as to relax the tendon of the biceps.

Backward dislocation of the head is quite rare, and when found may be due to a forcible contraction of the biceps, or to some abnormal fall or twist in which the tension pull of the external lateral ligament of the knee may rupture the tibio-fibular attachments allowing the biceps to pull the bone backward. Reduction can best be affected in flexion of the knee followed by direct manipulative pressure upon the head of the fibula.



Postero-mesial aspect of left fibula and posterior view of left tibia.

Luxations of the lower extremity are usually complicated with diastasis of the joint. They are comparatively

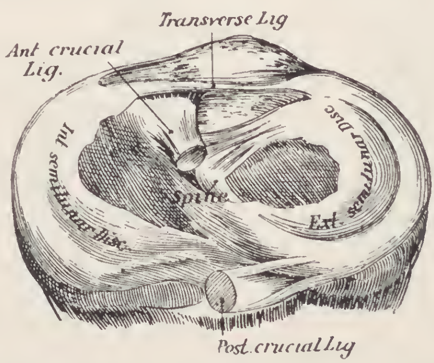
rare and are usually associated with Pott's fracture. Forcible inversion, or eversion may cause a dislocation of this nature.

The type of dislocation and a study of the particular direction of traumatic force by which it was produced suggests the particular moves to be utilized in effecting reduction.

Subluxation of the fibula is considered in chapter on the feet.

Derangement of the Semilunar Cartilages: These conditions were once termed Hay's derangement of the knee, as he was the first to call attention to them in 1803. They are usually traumatic in origin and more often encountered in males. The tendency for displacement is forward upon the head of the tibia so that the thicker posterior margin lies between the condyle and the tibia at or slightly in front of the point where they tend to come in contact. External violence or a twisting of the lower limb when the knee is in flexion is the usual cause of this condition.

The pathology of these luxations varies greatly. It may consist of only a slight slipping or subluxation of the cartilage. The cartilage may be dislocated, lacerated or torn. It may be thickened and roughened, calcified, hypermobile or



Upper surface of the right tibia, showing attachment of crucial ligaments and semilunar cartilages.

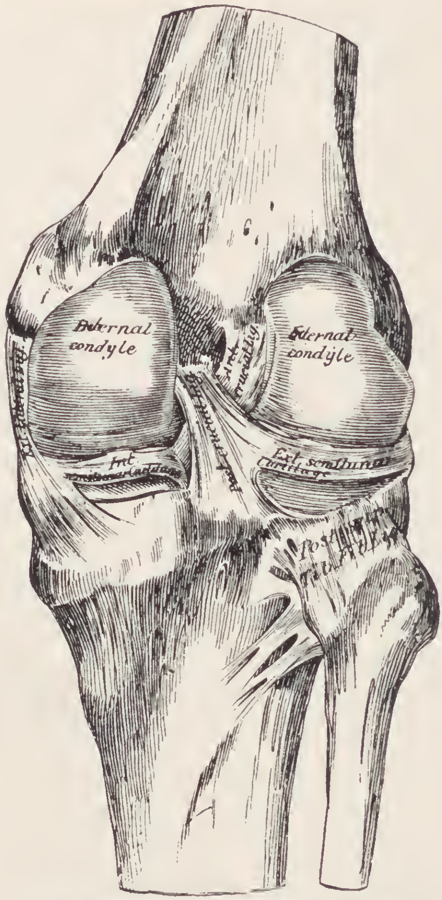
atrophied. It may be fractured and absolutely torn from its basic attachment. It may occasionally be fringed and give rise to attachment of fatty tabs. Detached fragments floating in the joint cavities are known as traumatic loose bodies and produce more or less irritation and inflammation of a traumatic character.

The symptoms and diagnostic features of this condition are: first the traumatic origin with a tendency to recurrent disability. The patient usually has a definite localized point of pain or tenderness over the palpable anterior border of the cartilage. Locking of the joint in flexion is present in less than fifty per cent of these cases, although the patient may feel that the knee is partially locked and complain of loss of power over the limb, which he can neither flex nor extend without effort. This sense of derangement and feeling of insecurity is characteristic. This condition is usually confined to the internal semilunar although a few rare cases have been reported of involvement of the external. The ratio is about seven to one. There may or may not be swelling in and around the cartilage. The cartilage is palpable when it is displaced forward and if not palpable, is not displaced in this direction. It must not be confused with swelling and tumefaction which usually follows. In some cases the cartilage appears to be absent, in others there is no apparent change although there are probable evidences of its involvement.

Reduction is not difficult providing the condition is not a complicated one. Surgery is demanded if there is considerable structural damage, but is not at all necessary if the condition is amenable to manual methods—which is usually the case.

Methods of Reduction:

Technique No. 1. With the patient sitting and the operator standing, facing the patient, the latter locks the lower leg of the patient slightly above the ankle joint between his knees. There is a point at which adjustment should be made which



Left Knee Joint—Posterior Aspect.

is in neither flexion nor extension—and is that point where the opposition of the flexors and extensors of the knee is so complete that there is no enforced tension limitation of either the hamstrings or quadriceps to a full range of lateral movement. At this point the lateral sweep is made toward the midline, holding the lower leg firmly between the knees as the lever to enforce gapping upon the joint, allowing plenty of room for the cartilage to return through the route by which it escaped from its normal position. At the same time this movement is carried out pressure should be directed against the projecting border of the cartilage, forcing it backward and inward toward the center of the joint. At the moment

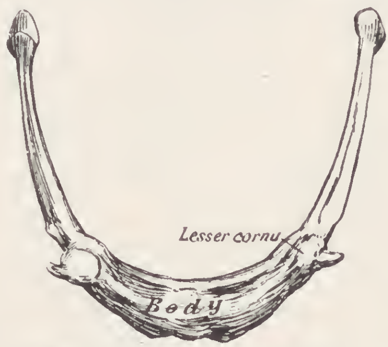
this is accomplished the lateral swing of the knee is reversed, closing in on the cartilage, crowding it to its full limit in a corrective direction, and firmly locking it in that position.

Technique No. 2. Patient supine. The operator stands on the same side as that of the limb involved. The knee is flexed. The operator grasps the foot and maintains it in an inverted position. Using the lower limb as a lever handle by which to enforce gapping upon the knee joint on its medial aspect, a fulcrum is established by bringing pressure of the torso against the lateral aspect of the knee. This gaps the joint on its inner side, and allows room for the cartilage to retrace its pathway. Force is then directed against the anterior outer border of the cartilage in a backward, inward direction toward the center of the joint. At the moment this pressure is at a point of culmination, an inward sweep of the foot is made, the lower limb is externally rotated so that the foot turns outward and at the same time the entire limb is carried toward the midline and the knee into extension. The objective in mind is to gap the articulation, force the cartilage into its proper position, and lock it in that position by the combination of direct force and leverage force, using the lower limb as the lever handle.

The after treatment may require stabilization by a pressure pad at the point where the cartilage tends to protrude, or occasionally a temporary brace that will limit the movements of the joint, as this will diminish the tendency to recurrence. Operative measures should be utilized when the condition is gross enough to warrant them and the pathology such that manual adjustive measures will not suffice. The reported results from operation have been uniformly good, the removal of the meniscus appearing to create no permanent functional difficulty.

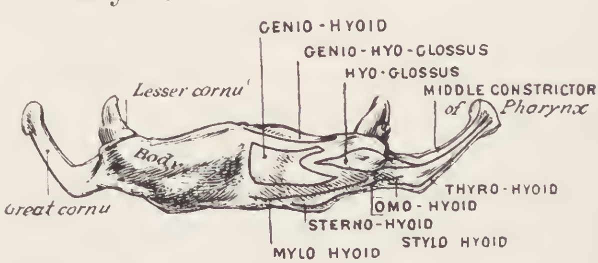
Derangement of the Hyoid: The hyoid bone is held in suspension in the anterior cervical column between the mandible above and the larynx below. It is connected to the styloid processes of the temporal bones

by the stylo-hyoid ligaments and is connected with the thyroid cartilage of the larynx by the thyreo-hyoid ligaments and membrane. It is connected with the root of the tongue posteriorly through its intimate association with the epiglottis. It is "U" shaped and consists of a body, two greater cornua and two lesser cornua. It gives origin to several muscles, namely the genio-hyoid, omo-hyoid, sterno-hyoid, thyreo-hyoid, stylo-hyoid, and hyo-glossus muscles.



Hyoid bone, seen from above.

Imbalance of tensions of its connecting muscular and ligamentous tissues may cause the hyoid to assume a twisted, tilted or otherwise abnormal position. Irritation of the laryngeal nerves may follow with symptomatic disorder of the pharynx or larynx.



Hyoid bone, anterior view.

Treatment consists in removing the muscular tensions producing the condition by stretching of the contractured tissues, using the hyoid as the leverage means. The hyoid will then assume its natural position providing the tissue imbalances are removed so that tensions are coordinate and equal.

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